THE AMERICAN GAS LIGHT JOURNAL

PUBLISHING OFFICE No. 32 PINE STREET

DEVOTED TO THE INTERESTS OF ILLUMINATION, VENTILATION, WATER SUPPLY AND DISTRIBUTION, & GENERAL SCIENCE.

VOLUME LXII.—No. 6. Whole No. 1,027. | NEW YORK, MONDAY, FEBRUARY 11. 1895 | $3 PER ANNUM, IN ADVANCE.

A. M. CALLENDER & CO., Proprietors. C. E. SANDERSON, Manager.
JOS. R. THOMAS, C.E., Editor. T. J. CUNNINGHAM, Asst. Editor.

ENTERED AT THE POST OFFICE AT NEW YORK, N. Y., AS SECOND-CLASS MATTER.

The Public Lighting Tables of the American Meter Company will be found in the page advertisement of that Company.

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An Asterisk (*) denotes an illustrated article.

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[OFFICIAL NOTICE.]

Twenty-fifth Annual Meeting of the New England Association of Gas Engineers.

OFFICE OF THE SECRETARY, February 1, 1895.

The twenty-fifth annual meeting of the New England Association of Gas Engineers will be held at the Parker House, Boston, on Wednesday and Thursday, February 13 and 14, 1895.

Papers will be presented entitled :

"Some Card Catalogues in Use for Records of the Outside Work of a Gas Company," by Mr. S. J. Fowler, Springfield, Mass.

"The Effect of the Introduction of the Welsbach Lamp on the Business of the Gas Company," by Mr. Jos. E. Nute, Fall River, Mass.

"Notes," by Mr. W. A. Wood, Boston, Mass.

The following topics for discussion will also be presented :

"Carbide of Calcium : Its Advantages as a Gas Making Material and an Enricher."

"What is the Best Course to Pursue When a Person is Overcome by Gas Inhalation ?"

"Electrolysis."

Each of these topics will be spoken upon by several members of the Association, and it is also hoped to have present other gentlemen familiar with the subjects.

The following question has also been sent to the Question Box :

"What is the Average Amount of Gas Burned Per Annum by a Gas Range; and how much has the Introduction of Gas Stoves Increased the Output of Gas ?"

It is requested that members will prepare their data on any of the above mentioned subjects, and come ready to contribute their share to he general information.

The meeting will be called to order at 10 A.M. Wednesday, Feb. 13, and the members will dine together as usual on the evening of that day, at 6:30.

Application blanks for membership may be had of the Secretary. Applications for membership and all other matters for the consideration of the Directors should be sent to the Secretary before Tuesday evening, Feb. 12.

C. F. PRICHARD, Secretary.

[OFFICIAL NOTICE.]

February Meeting, Society of Gas Lighting.

OFFICE OF THE SECRETARY, February 10, 1895.

The February meeting of the Society of Gas Lighting will be held in The Arena, No. 39 East 31st street, at 3 P.M., Thursday, the 10th inst.

FRED. S. BENSON, Secretary.

[OFFICIAL NOTICE.]

Second Annual Meeting, Michigan Gas Association.

OFFICE OF THE SECRETARY, SAGINAW, MICH., Jan. 23, 1895.

To the Members of the Michigan Gas Association—Gentlemen : The second annual meeting of the Michigan Gas Association will be held in Saginaw, on February 20th, 1895, and will be called to order at 9 o'clock, A.M., sharp. As the meeting is of but one day's duration, it is absolutely essential to begin business early. Please bear this in mind.

The headquarters of the Association will be at the Hotel Vincent, a new and beautifully furnished steam-heated house. Although the house is usually lighted by electricity, arrangements have been made by which our members will not be compelled to use it. The usual rates charged are $2, $2.50 and $3 per day, but it is arranged that a uniform rate of $2.50 will be charged, with a preference to the better rooms.

The meeting of the Association will be held in the parlors of the hotel, and we are promised the best that the house affords. Members and those wishing to meet with us will please write the Secretary engaging rooms ahead of time, for we are to have a very large meeting this year, and it is advisable to house all at the same place.

The following papers will be presented for consideration :

"The Heating Effect of Artificial Lights," by Mr. Henry W. Douglas.

"Federation," by Mr. C. H. Raynor.

"Opposition Gas Companies," by Mr. Joseph Walker.

"Whose Make of Lighting Fixtures Shall We Recommend ?" by Mr. W. M. Eaton.

Although the Michigan is yet small in numbers and Saginaw seemingly away out in the woods, it is but three hours' ride from Detroit, and easily reached from all directions. We will therefore expect not only every member, but a great many more who will become members, to meet with us at this time. Very respectfully yours,

HENRY H. HYDE, Secretary.

[OFFICIAL NOTICE.]

Eleventh Annual Meeting, Ohio Gas Light Association.

OFFICE OF THE SECRETARY, COLUMBUS, O., February 1, 1895.

To the Members of the Ohio Gas Light Association : The eleventh annual meeting of this Association will be held in the parlors of the Arcade Hotel, Springfield, O., March 20th and 21st, 1895 ; and it is hoped that every member will be present and take an active part in the meeting.

A list of papers to be read will be announced later.

A. P. LATHROP, Secretary.

BRIEFLY TOLD.

THE MEETING OF THE NEW ENGLAND ASSOCIATION.—According to Secretary Prichard's completed circular, the Silver Wedding meeting of the New England Association will be lacking neither in interest nor value, for the programme shows that their mother's sons have been up and doing to keep her in accord with the things prominent and current in the practice of their profession. It looks that the paper list is limited as to separate numbers, but it is beyond cavil prolific in promise of spurring to lively discussion, especially when consideration is given to the fact that the list of itself is to be supplemented by three "topics for discussion," at least two of which are certainly live questions with the gas engineer. Mr. Nute's paper on the effect of the introduction of the Welsbach lamp on the business of his Company, will likely prove the most positive incentive to discussion, since it is sure to deal with the matter from the standpoint of a man who, while closely watching the standing of the electric light suppliers of Fall River, Mass., and their maneuvers as well, has nevertheless contented himself with administering only to the gas needs of that community. Mr. Nute, too, brings to his subject nothing other than the criticism which springs from well-ordered thought and level-headed observation, wherefore his recital of experiences in the line indicated may be accepted without the idea that his findings are the records of an enthusiast. Mr. Fowler's well known capacity for accurate and systematic methods in his routine working guarantees the putting out of a card-recording plan that will be taken advantage of by others in their own field of work. Mr. Wood, as usual, selects a title for his paper that gives no inkling to its contents; but if it equals his "Items from a Superintendent's Note Book," read by him before the Association in 1888, there is nothing other than satisfaction in store for his audience and applause for himself. In the topics for discussion the likeliest one seems to be that which is to have Carbide of Calcium for its subject—since this product of the electric furnace has won its way to being talked about the world over. In fact, it seems to have appealed with the greatest force to our English brethren, one of whose most prominent gas men (Prof. Lewes), if he is to be taken literally, in view of his recent lecture before the English Society of Arts, rather favors the idea that the enrichment of lean English coal gas is to be accomplished in greater and cheaper degree by calcium carbide than by any of the many oil methods, which latter systems have good American backing behind them now in Prof. Lewes' country. Be that as it may, American engineers are not yet enthusiastic over the calcium carbide plan of enriching, for the belief is pretty well defined here that the material cannot be produced at a price that will enable it to compete with cannel coal at $10 per ton, or with naphthas at 4 cents per gallon—say in the vicinity of New York. President Nettleton's annual message will, of course, be of the sort that that well-balanced man can evolve; and we know it will be up to the times, since he has been looking up the public gas pulse on Presidential account for the last three months. To sum up, it may be remarked that Mr. Prichard has managed to get together a very handsome programme, which should call for a right good attendance at Parker's, this week.

MR. HENRY C. KELSEY ON THE GRUBER-STEVENS GAS BILLS.—A week ago we had occasion to say a word or two about the evidence presented at the State House, Trenton, N. J., in support of the measure which proposes to order a dollar gas rate in the chief cities of New Jersey, which mention had to do with the ridiculous assertions advanced by one Levi Stevens, of Stevens gas process fame, respecting what could be done by him—had he only half a chance. On Tuesday last, however, the Committee having the bill in charge listened to arguments on behalf of the legitimate gas interests of the State, and the feature of the hearing was the masterly argument made by Mr. Henry C. Kelsey, whose clever puncturing of Stevens and his stories was most complete. Mr. Kelsey spoke not from the standpoint of an unevenly balanced promoter of windy gas processes, but from the platform of a man experienced in the manufacture and sale of gas on a large commercial scale. His calm and well fortified presentation of the case was in queer contrast to the incoherent jabberings of the discredited process man, and we have little doubt that the Trenton law makers will in the end be discerning enough to sift fact from fancy.

NOTES.—Mr. William McDonald, of Albany, N. Y., was united in marriage to Mrs. Ida A. Snodgrass, of Vincennes, Ind., on the morning of the 5th inst. The marriage ceremony was performed by the Rev. Mr. T. S. Scott, of the Vincennes Presbyterian Church, after which a very complete wedding breakfast was served. In wishing Mr. and Mrs. McDonald every possible happiness and success, we know that we voice the desire of every member of the profession of which the groom is so staunch a member.——Mr. Alfred Zucker, the architect for the handsome apartment house that is being erected at the corner of 58th street and 5th avenue, this city, has placed an order with Messrs. William M. Crane & Co., for 10 large wrought steel ranges, which means that gas will be used exclusively throughout the house for cooking purposes. Each range is to be equipped with a "Perfection" gas controller, to prevent waste of gas.

The Discussion on Prof. V. B. Lewes' Paper on the Commercial Synthesis of Illuminating Hydrocarbons.

A week ago (p. 146) we gave the text of a paper by Vivian B. Lewes (read before the Committee of the Society of Arts, of London, January 16th) in which the author discussed the commercial synthesis of illuminating hydrocarbons, devoting himself chiefly to a consideration of calcium carbide. The paper was followed by a brisk discussion, a report of which is appended:

Mr. Lewis T. Wright remarked that the lecture was peculiarly interesting to technical men, probably in a double sense, because they had an interest in the scientific side, and also in the possible commercial side, of any such reaction as Prof. Lewes had described. There was one question he must ask, and that was whether, in the course of the Professor's experiment, he had proved that the high luminosity of acetylene was retained when it was mixed with coal gas, for example, as an enricher—whether, *pro ratâ*, acetylene, per cubic foot, had the 50 candles illuminating power that it had when it was burned in the pure condition. Probably this experiment had been tried. It might be thought by many present that this would necessarily follow; but he had reason for knowing that in such cases the luminosity produced by mixtures of gases of different qualities was not always the arithmetical mean of that of the gases employed. This was rather an important point, which it would be interesting to have explained.

Mr. W. Sugg said the whole matter just brought before them was so surprising, from many points of view, that it was extremely difficult to offer many remarks upon it. One thing that particularly struck him was the fact that acetylene appeared to have such a powerful affinity for oxygen. They generally found, when they tried to burn gas of very rich quality, that it was difficult to get enough air mixed with it to provide a sufficient quantity of oxygen to produce a brilliant light. But from the gas before them, which he should have thought would have given a very smoky flame, they had a highly brilliant one. This could only result from the fact that the oxygen of the atmosphere had such a powerful affinity for it that it rushed to it, and so provided it with a greater amount of oxygen than could be furnished by any means known—except, perhaps the Welsbach light—for bringing the oxygen of the atmosphere into combination with the hydrocarbons of the gas. The gas before them seemed to be really as brilliant as if it was burning as an oxy-hydrogen light. Having never seen the thing before, he could not say whether or not his view was correct; but it seemed to him that the reason he had given was the only explanation of why it was possible to get such a light from so very rich a gas. There did not appear to be much specialty in the burners.

Professor Lewes said there was a little; but still, in the main, Mr. Sugg was right.

Mr. Sugg said he could not imagine that any difference in the burner would produce that magnificent light without an extraordinary affinity of the gas itself for oxygen. As to the manufacture of the gas itself, it seemed so easy that most of them thought they could probably do it straight off for themselves. He did not know whether or not this was possible. Perhaps they might find some difficulties when they came to try it. At any rate, there was certainly a very wonderful effect produced, and the matter ought to be thoroughly examined.

Mr. C. C. Carpenter said he must first congratulate Professor Lewes on the result which had followed his well known researches into the effect of acetylene on the luminosity of gas light. The fact that in so short a time afterwards one was able to manufacture acetylene on a commercial scale, must have been a very pleasing surprise to him. He (Mr. Carpenter) would like to emphasize the point Mr. Wright had put with reference to the enriching value of acetylene; and he was somewhat disappointed that it was not expressed in the way Mr. Wright had suggested as being desirable, viz., the enriching instead of the direct effect, which was, of course, more important, supposing acetylene to be used on the scale which Professor Lewes considered would come about in the very near future. It was somewhat difficult to discuss a paper of which one had no knowledge beforehand; but one point that occurred to him was with reference to the production of the carbide of calcium at the figure mentioned—$20 a ton. It seemed to him that, for the manufacture of an article which could only be obtained by the aid of an electric furnace, this price per ton was very low; and he should be glad if the author could throw some light on the method of producing electricity for forming the carbide. The whole thing hinged on the commercial aspect; and the more light the author could throw upon the cost of the carbide per ton, the more value would attach to it from a commercial point of view. At any rate, Professor Lewes had done something which would be a great relief to the electric light engineer,

as he would at last be able to get a level load line on his machinery by employing it to prepare a material for the manufacture of gas.

Mr. T. S. Lacey said one thing which struck him was that a great many people thought some process such as that of Mr. Young should have been adopted more largely by gas companies, on account of the cheapness of the gas produced. In a gas such as they had in London, however, the amount of enrichment was really a small percentage of the total value of the light; and consequently that portion of the light varied very much. Sometimes they were obliged to add one candle, sometimes two candles, and at other times only half a candle, while occasionally they added nothing at all. The result was that the plant necessary for the maximum amount of enrichment would have to be equal to the use of 10 or 15 per cent. of cannel—that was to say, for the heaviest make in winter; and this wou'd necessitate having a very large plant on the works in order to deal with the lowest requirements. This necessitated large capital outlay for the Young plant. Where carbureters were used, the first cost of the plant was rather low; and it would be in favor of this method that the capital outlay for enriching would be very small. The interest on capital laid out for plant for making oil gas, where the requirements varied over one week from 10 to 15 per cent. of cannel to nothing at all, would be very large.

Mr. J. W. Helps said he could only reiterate what had been said by previous speakers—that the subject brought before them had been extremely interesting; and they all hoped it would be of great advantage to the gas industry in the future. In speaking of the process of enrichment, which was suggested in connection with the acetylene, Professor Lewes said it would be employed much in the same manner as the Maxim-Clark process—that was to say, it would be applied to the gas after leaving the holders. He should like to ask Professor Lewes if he had tried whether this gas had any effect on the prevention or the absorption of naphthaline deposits. Many companies were now using these enriching bodies partly with the general idea of improving the gas, and partly with the view of preventing or removing naphthaline. This seemed a most important point, and one, no doubt, which Professor Lewes had gone far to clear up. He must also agree with what Mr. Carpenter had said with respect to the cost of production of this carbide of calcium. It seemed to him that, produced as it was by an electric current, it was a remarkably low price; and, as it came from the other side of the Atlantic, he should like to ask whether it was not based on electricity produced by water power.

Mr. Frank Mead said the subject brought before the meeting in the paper had been quite a novelty to those interested, and, in particular, to those who were connected with the gas industry. Former speakers had touched on one or two points which he should have dealt with himself, more particularly with regard to the commercial aspect of the question—the cost of the production of the carbide. If it was produced as a bye-product where a process was going on of which the object was to get some other substance, and this material was obtained incidentally, one could understand that it might be sold at a comparatively low price; but if the electric furnace was at work for the sole production of the material, would it then be possible to produce it at $20 a ton? Of course, if it were extensively used, it would have to be capable of production in large quantities; and he took it that, if the gas interest of the world were to adopt such a process, and if it were found advisable to use it, the quantity of material required would be extremely great. What effect this would have on the price, it was difficult to say. Another point of great interest which had not been mentioned was this: Professor Lewes said that the acetylene gas unburnt had a remarkably unpleasant odor which made itself manifest, so that no one would care to stay in a room where there was such a large proportion of it present as to be dangerous to life. But was there any odor given off when the gas was consumed at the burner? Professor Lewes had observed that it would be useful for burning out of doors; but was it perfectly odorless when burnt in a room? One could see no reason why there should be an odor produced by its combustion; but this was a point which deserved attention. Another was this: There must be a vast difference between the specific gravity of ordinary coal gas and that of acetylene, and he thought there might, perhaps, be some "layering" of the two gases when mixing one with the other so as to produce the required compound. The mixture of it with ordinary gas as it went away from the holder was a very different thing from adding the enricher to the gas that went into the holder. There was not the same opportunity for layering in the one case as in the other. He could only add his tribute of praise to Professor Lewes for the way in which his lecture had been delivered.

Mr. Frank Wright said he desired to ask Professor Lewes one question; but, before doing so, he would like to recall to memory a little ditty by the late Mr. F. W. Hartley, which he wrote in praise of electricity and gas going hand in hand. It must be very gratifying to both gas and electrical engineers, not only to listen to the brilliant lecture they had heard, but to find that electricity was, to some extent, offering to befriend gas. In the case of a recent explosion, and in other things, the reverse had been the case. He now wished to ask Professor Lewes if he had any information as to the value in candle power of the horse power of electrical energy, as it seemed to him that everything hinged upon that. If gas companies did not take up this process, perhaps the electrical concerns might work it round in one of those little cycles of synthesis and analysis of which they had heard.

Mr. H. O'Connor asked if Professor Lewes could say what would be the result of mixing acetylene with water gas—whether or not it would be an explosive mixture; because, if not, the smell given off from the acetylene might be a means of causing water gas to be used, by enabling one to know when it was escaping.

Mr. Manuel asked whether, if an escape of acetylene took place in a room, and the gas united with the atmosphere, there would be a danger of explosion if anyone went into the room with a naked light; and, if so, would it be more severe than in the case of an ordinary gas explosion.

Professor Lewes, in reply, remarked that it was very curious how, in a discussion of the character of the present one, it was always found that particular stress was laid on the very point which one wished to keep locked up in one's own breast for a short time. When he saw Mr. Lewis Wright rise, knowing what a master of the whole subject he was, he (Professor Lewes) fully expected something of this sort would follow. Enrichment was one of the most complex questions they could have to deal with; for they found that enrichers varied, as Mr. Wright had pointed out, to an extraordinary extent. If they took an enrichment curve, they never found it to be one of those regular, convenient curves, in which they had 1 per cent., 2 per cent., and so on, going up in proper proportion, but one in which they always had a flattish piece at the bottom, and then gradually rising to the proper point. This had been overlooked time out of mind. He was now working out the enrichment value for a large number of pure hydrocarbons and hydrocarbon mixtures; and he thought he was gradually getting to the bottom of the secret which had been so hampering people in this matter. He did not propose to bring this forward at the present moment, as he wanted it for another paper; but he could answer the question about acetylene. When they added acetylene in small quantities to coal gas, the enrichment value was about 1¼ per cent. at the bottom of the curve. From this it went up fairly rapidly, until, when they were making 50-candle gas, it reached nearly its maximum enrichment. The addition of 1 per cent. gave about 12 candles for low values; and then they had a rapid rise until it went to 50 candles. This was also the case with ethylene, ethane, and several others.

Mr. L. T. Wright said he gathered that at 50 candles they obtained the same value in the mixture as in pure acetylene.

Professor Lewes said they came very close to the true value. This was the case with coal gas; but with water gas—and this would answer another query—for a reason of a very beautiful character, it was practically hardly of any use as an enricher. This was why it was found that, in American practice, they talked about 80 or 90 candles. If they took pure water gas—carbon monoxide and hydrogen, with small traces of impurities—and mixed 10 per cent. of acetylene with it, they would have a non-luminous flame. He knew the reason of this; but he could not on that occasion go into it. It showed, however, that acetylene was absolutely useless for the enrichment of gas of that character. With hydrogen, alone, or with carbon monoxide alone, of low value, it was of no use; but when they came to high values, its power appeared once more. Exactly the same thing was found by Dr. Percy Frankland in regard to ethylene. But with coal gas the enrichment value was very great; and this for perfectly apparent scientific reasons. No doubt the burning question, after that of enrichment, was the price of the carbide; and he believed that, in the American experiments which were quoted, giving a price of $15 per ton, undoubtedly water power was used for the production of the electricity. But there was another point in this connection he would ask his hearers to think over. Acetylene was not only a benefactor to the gas world, in the direction of enrichment, but he should say that it would also be a benefactor to the electric world. They all knew that, in the big installations which were being employed for the development of power for supplying incandescent and other electric lights, there was only a possibility of using the plant for one-fifth of each day. Therefore the electric lighting companies had to pay interest on all this dead time; and they had to make, or try to make, dividends in the

face of this tremendous obstacle. This meant not letting the fires out, but banking them up; and the long standing of the plant was a great trouble. They were all aware what happened to the plant, which stood for four-fifths of its life; and he ventured to think that, when it could be shown that there was a market for calcic carbide, they would find at the same time that many of the big generating stations would be glad to regard as a helper rather than as an enemy, the making of this material for producing acetylene. Electric lighting was not all in the hands of one corporation. If it were, they might consider it worth their while to stifle this manufacture, if they thought its illuminating value was going to interfere with them. But there were a number of corporations, all struggling one againt the other to show good returns; and he ventured to think that, if they could use the leads from the dynamos for an electric furnace during the hours of daylight, and for the generation of light during the other period, there need be no fear that they would not be able to get a supply of electricity for this purpose at a reasonable price. This was his own view. He did not know how far it was practicable, and how far not practicable; but it appeared to him, on the surface, as a fairly tenable argument. Mr. Sugg looked with surprise on the possibility of being able to burn gas of such high illuminating value as that of acetylene; and he pointed out that this must be due to its having a very great affinity for oxygen. But the luminosity of a flame was not due entirely to its affinity for oxygen. The light obtained from a flame was dependent upon certain exceedingly complex chemical reactions, a few only of which had yet been thoroughly worked out; and it might be a surprise to many present to find that the acetylene flame, giving the marvellous light they had seen, which suggested incandescence of the highest character, was a flame far cooler than that of an ordinary gas-burner. With 16-candle coal gas, the flame had a temperature in various parts rising as high as 1400° C. In the case of the acetylene flame, in no part was there a temperature of more than 900° C.; and being a cool flame, the products of combustion came off at a temperature which would render it pleasant in a room. There would be no overheating from the flame; and, moreover, there were no noxious products of combustion. There were no products which were in any way offensive to the senses, and none of incomplete combustion. If there were incomplete combustion, the flame would smoke so furiously that it could not be allowed to go on; and it was only when there was incomplete combustion that any smell would arise. This would only give rise to the same products that were given off in the incomplete combustion of ordinary coal gas—viz., simply carbon dioxide and water vapor; and, considering its high illuminating power, the quantity produced was exceedingly small. When they came to read the paper in print, it would be found that some of the points which had been raised were dealt with, but which he had omitted in delivering his lecture—for instance, the specific gravity of the gas was stated as .91, or about double that of coal gas. It must be remembered that, when they mixed the gas in bulk, thore was no stratification if it was done before it went into the holder. This did not mean simply tumbling one gas into the other, which would cause stratification; but the amount they would have by putting the gas, at a regular rate, into the outlet main would not be nearly so great as in the other case. One important point had been raised by Mr. Lacey on the subject of enrichment. They all knew that—for instance in London—there was a perfectly monstrous waste of enrichment in order to obtain the statutory quality of gas. At Beckton, for example, enough enrichment had to be put into the gas to bring it up to a safe limit above 16 candles at the burners. At the present time they were employing processes of enrichment, such as carbureted water gas; and, in order to make quite sure of not being penalized, the gas was being sent out at a margin above the statutory limit, which was quite absurd. In the City, more often than not, 17-candle gas was being supplied, simply to avoid the enormous chance of a change in temperature bringing down the illuminating power and so rendering the Gas Company liable to a penalty. All practical men would agree that this was entirely wrong. There ought not to be the necessity for putting in this surplus enrichment. As a matter of commercial dealing, if they had to supply 16-candle gas, it was only reasonable that they should supply it as near to 16 candles as possible, and if they had a process which needed so large a margin of safety, it was a wrong process. It needed this large margin, because, where they relied on anything which consisted to a considerable extent of vapors, they must have a sufficient surplus to prevent the risk of the "skin friction" in the mains, which was an even more important factor than cold, in bringing it out again. If they employed acetylene in the same way as they used the Maxim-Clark process, they could enrich the gas coming from the holder up to 16.4 or 16.5 candles, and there would not be the remotest chance of this power coming out of it, because they would not be dealing with a vapor, but with a fixed gas. He thought this fact would commend itself to the mind of every gas manager. The point raised by Mr. Helps was whether, when they enriched by means of acetylene, it would have any effect on the naphthaline. It would not. Naphthaline was taken up by gases like those that were given off by petroleum spirit or naphtha, such as was used by the Maxim-Clark process, because they had there the solvent effect of the vapor of a liquid. The vapor of these light hydrocarbon oils would dissolve and move on the naphthaline; but acetylene would not. Mr. Frank Wright asked a question as to the relation existing between candle power and electric horse power; and he (Professor Lewes) should put it in this way. If they took an electric horse power and converted it into the incandescent light, and if they also converted this horse power into calcic carbide, and then obtained the illuminating power from it, the respective values might be taken as 28 : 44. He had only, in conclusion, to thank his audience for having treated his subject so leniently, and he hoped it would prove to be of permanent value.

The Chairman then proposed a hearty vote of thanks to Professor Lewes for his admirable lecture. He said it seemed to him that they were indebted to the lecturer for showing them how an ornamental gas works might be made, and apparently at very much less cost than the present structures, which could not possibly, by any stretch of the imagination, be called ornamental. Another thing that struck him was that they seemed to be getting very near to that great *desideratum* of a level load line in electrical matters; and that the process before them would afford a very good form of storage battery for electricity. The electric energy in the furnace came out in the form of a stick, which could be carried in the pocket, and which would give a certain amount of brilliant light again whenever one wished, and could find a little water into which to put it. It was really, therefore, a case of storage of electricity in an extremely convenient form; and, bearing in mind that the really serious difficulty in electric lighting was the idle hours to which Prof. Lewes had alluded, it appeared to him (the Chairman) not at all improbable that, after all, the best way of utilizing electricity would be to convert it into a light something like that which had been exhibited.

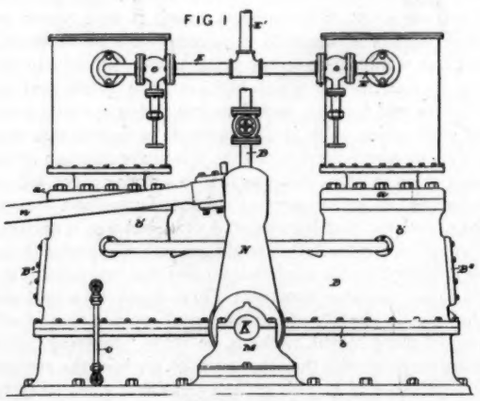
The vote of thanks was carried unanimously.

Farnsworth's Gas Compressing Pump.

According to the *American Engineer* the objects of Farnsworthis gas compressing pump are to reduce the height of a vertical machine, to facilitate access to the parts and relieve the foundation of strains; to reduce to a minimum the angularity of the connecting rod during the latter part of the stroke, and to improve various details of construction.

In the accompanying drawings, Fig. 1 is a side elevation of a double cylinder compressor embodying the improvements; Fig. 2 is a vertical section thereof, and Fig. 3 is a cross-section on the axis of the rock shaft.

FIG 1



Side Elevation.

The cylinders *A A* (Fig. 2) are open at each end, and are supported by flanges *a* on a suitable base, *B*, consisting of preferably two parts united by a packed joint *b*, on a horizontal plane. The upper portion of the base has two necks, b^1, in which the cylinders are received, their lower ends depending into the base, as shown. The joint between the

neck b^1 and the flange a is packed, so that the base forms a gas-tight chamber. A pipe, B^1, provided with a suitable stop valve, connects the base with the evaporating coils. The lower portion of the base is preferably in one piece, to form a reservoir for lubricating oil. At B^2 are covers to hand holes for giving access to the bearings of the connecting rods. In each cylinder, just below the flange a, are one or more ports, a^1. The upper end of each cylinder is closed by a check valve C, which cuts off the cylinder from a chamber D, from which proceeds a discharge pipe E, having a stop valve e, and connecting with a common pipe E^1, running to the condenser.

In each cylinder is a piston F, tubular in shape, and provided with a number of packing rings f. The upper end of the piston forms a seat for an upwardly closing valve G, which slides on vertical guides f^1, on the inside of the piston. A ring f^2, screwed into the lower end of the piston, limits the play of the valve. A socket is formed in the under side of the valve to receive the ball h on the upper end of the connecting rod H, the ball being confined in the socket in any suitable manner, as by a gland g. The lower end of the rod H is provided with brasses h^1, for connecting it with a wrist pin i, on a rocker I. The brasses can be adjusted by a wedge h^2, and screw h^3.

The rocker I is keyed to a shaft K, journalled in bearings b^3, integral with the lower portion of the base. The rocker has a working fit between the inner faces of these bearings, which are bored out cylindrically, and are lined with bushings L, turned to an outside fit in the bearings and bored out to suit the long and preferably taper journals k on the shaft K. A gas tight cover b^3 incloses one end of the shaft. The other end passes through a stuffing box B^3, and is supported in an outboard pillow block M. The axis of the shaft lies preferably in the plane of the joint b, between the upper and lower portions of the base. Fastened to the shaft outside the base is a rocker arm N, to which may be attached a rod n, for connecting it with an engine or other motor.

The wrist pins i and shaft K are not in line with each other, but the shaft stands above the line joining the pins, so that each pin is distant from the shaft more than half the distance between the axes of the cylinders A. The proportions are such that when a piston is at the bottom of its cylinder, as at the right of Fig. 2, the angularity of the rod is the greatest; but when the piston has made half its up-stroke, the pin i intersects the axis of the cylinder, and the rod coincides with said axis. The continued upward movement of the rocker arm swings the rod slightly outward for the next quarter of the stroke, but during the last quarter the rod again approaches a central position, which it reaches at the end of the stroke, as seen at the left of Fig. 2. The dotted lines in this figure show the paths of the pins i. It thus appears that during the latter half of the stroke, when the resistance of the gas in the cylinder is greatest, the angularity of the rod is least, thus reducing to a minimum the wear and strain. It also appears that the line joining the center of the wrist pin and the axis of the shaft does not stand at right angles to the axis of the cylinder until three-quarters of the stroke has been made.

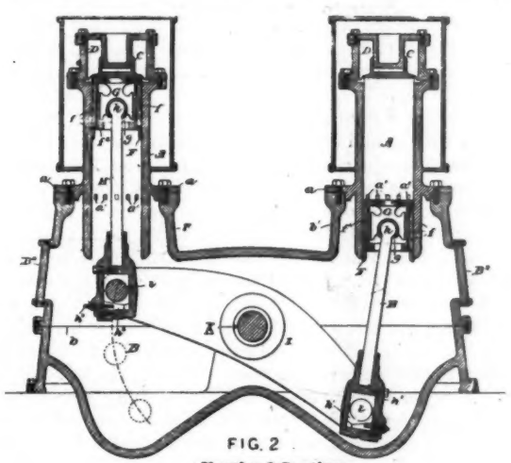


FIG. 2

Vertical Section.

In operation, the downward movement of the rod H first draws down the valve G from its seat in the upper end of the piston. When the lower end of the valve strikes the ring f^2, the piston is carried downward, the gas in the base passing into the cylinder past the open valve G. On arriving at the bottom of its stroke the piston uncovers the ports a^1, which permit the gas to enter the cylinder freely and insure a full charge at evaporating pressure. The upward movement of the rocker arm first closes the valve G and then carries up the piston, compressing the gas in the cylinder until it equals the pressure in the condenser, when the check valve C opens, and the gas passes into the condenser, where it is liquefied. The construction of the piston is such that there is perfect freedom from restraint, avoiding unequal wear, and insuring prompt and correct action. The ball joints, guides in the pistons, pins and shaft bearings are all lubricated by the oil in the lower portion of the base, which is preferably carried at the height of the center of the shaft K, but may be varied to suit. The level of the oil is shown by a gauge. At each stroke the descending rocker arm throws up a spray which amply lubricates the parts not immersed in the oil.

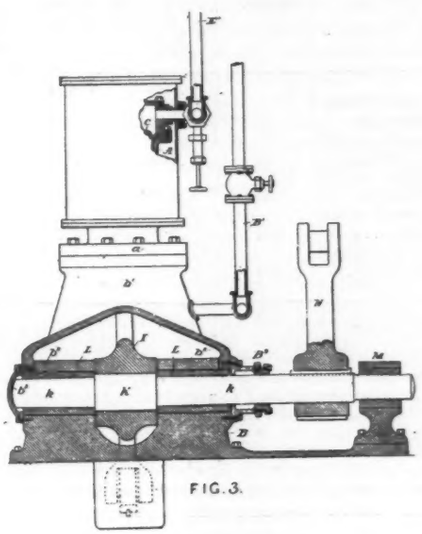


FIG. 3.

Cross Section.

The inventor is Mr. Thomas Farnsworth, of San Antonio, Tex. His patent is numbered 530,097, and dated Dec. 4, 1894.

The Selection of Motive Power.[1]

[By Mr. Charles E. Emery, Ph.D., in *Engineering Magazine*.]

Another type of moderate speed engine has been developed, in which the details of high speed engines are used, thereby securing a somewhat simpler engine, some forms of which are also economical.

The accompanying table shows approximately the cost of steam power under conditions differing as to the amount of power required and the type of engine employed. The calculations are based upon the average results obtained in practice rather than those shown under merely experimental conditions. The cost of coal at $3 per ton is derived from conservative but fair values of the water per indicated horse power per hour, as well as the evaporation per pound of coal for the several engines and powers stated in columns 2 and 3. On such basis the coal per indicated horse power per hour varies from 5.6 pounds for the small simple engine to 1.65 pounds for the triple compound engine; whereas, experimentally, an indicated horse power should, with an engine of the kind last named, be obtained for less than 1¼ pounds of coal. The conservative quantities mentioned are increased to allow for 10 per cent. friction between the horse power in the cylinders and that delivered at high speed to a jack-shaft or equivalent; and, in addition, 10 per cent. is allowed for the various wastes incident to starting and stopping fires, so that the hourly cost of coal in column 4 is higher than would be determined by a mere theoretical discussion, though believed to be fairly correct for the conditions of average practice. The costs given for labor, supplies and repairs, in columns 5 and 6, have been derived from such costs under actual practical conditions. In columns 7 and 8 it is assumed that the cost, under average conditions, for taxes, insurance and a contribution to a sinking fund to provide for renewals, is 5 per cent. of the estimated total cost of the machinery in place, including foundations, buildings and chimney; in addition to which, in column 7, 5 per cent. is added for interest on first cost, or dividends on stock representing the same; and, in column 8, an alternative charge of 10 per cent. for the same purpose. The latter is believed not to be too high for the

1. Second paper. For first paper, see JOURNAL, Jan. 7, 1895, p. 6.

Cost of Steam Power.

1	2	3	4	5	6	7	8	9	10	11	12	13
			Cost per Net Horse Power.									
	Kind of Engine.	Net Horse Power.	Per Hour, at $3.00 per Ton.*	Per Hour for Labor.	Per Hour for Supplies and Repairs.	Per Hour for Sinking Fund, Taxes and Insurance; 5 per Ct. of Total Cost Added to.		Per Hour for Coal, Labor and Supplies.	Total per Hour.		Total per Year of 3,000 Hours.	
						5 per Cent. Interest and Dividends.	10 per Cent. Interest and Dividends.		For 5 per Cent. Interest.	For 10 per Cent. Interest.	For 5 per Cent. Interest.	For 10 per Cent. Interest.
			Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Dollars.	Dollars.
A	Ordinary non-condensing	10	.9705	1.00	.28	.1948	.2921	2.25	2.45	2.54	$75.46	$78.31
B	Automatic cut-off non-condensing	75	.5556	.37	.19	.2110	.3165	1.11	1.33	1.43	40.96	44.04
C	Automatic cut-off condensing	150	.4239	.25	.14	.1948	.2921	.814	1.01	1.11	31.11	34.19
D	Compound condensing	250	.3465	.17	.09	.2078	.3117	.607	.815	.919	25.18	28.40
E	Triple compound condensing....	500	.2697	.11	.08	.2338	.3507	.460	.694	.811	21.38	25.06

*As stated in the text, the coal per hour has been calculated on a conservative basis designed to represent average practice rather than the results possible with apparatus in perfect condition. The basis is 42 pounds of feed water per H.P. per hour for line A, 28 pounds for line B, 22 pounds for line C, 18 pounds for line D, and 14 pounds for line E, and evaporations per pound of coal of 7½ pounds for line A, 8.25 pounds for line B, and 8.5 pounds for the remaining lines. With engines of the kind stated, proportioned for the work and in good condition, the water consumption should be 2 pounds less for each engine, and an evaporation of 9 pounds of water or better per pound of coal could frequently be obtained. As the costs are generally stated for the indicated horse power, it should be noted that a friction of 10 per cent. has been assumed to cover losses not only in the engine, but due to transmission to a jack shaft. For engines running 24 hours per day, the allowance of 10 per cent. of the fuel for starting and stopping fires should be decreased. Engines generally keep up their economy for long periods, but the amount of coal is frequently increased by carelessness in connection with the selection of the fuel, the firing, care of boilers, etc.; so, even if the engines require 2 pounds less water than assumed, the coal required generally costs fully as much as stated.

ordinary work of stock companies, as the company would in general endeavor to raise the actual cost on bonds upon which interest must be paid, and expect to pay, in addition, a dividend on stock of like amount. Columns 10 and 11 show the total cost in cents per net horse power per hour, the former being on the basis of 5 per cent. interest, and the latter on the basis of 10 per cent. Columns 12 and 13 show these quantities so extended as to exhibit the corresponding costs per horse power per year. A study of the table shows clearly that the cost of the power decreases rapidly as the power increases, independent of the cost of coal, which is decreased by the use of more economical engines. The cost of labor largely influences the result first stated, although for the smaller engine only part of the services of one man has been charged. For the larger engine the interest has a much larger influence than is generally considered. Considerably lower costs are frequently given, for the reason that a less conservative and practical basis is employed to ascertain the cost of the coal; and, moreover, many of the items of cost herein stated are frequently omitted entirely, though all have an important influence on the final result. For more elaborate investigations on this subject, more extended tables prepared by the writer may be consulted.[2] It should be borne in mind, however, that all tables are necessarily based on assumed conditions, and therefore only show approximately the results to be expected in a particular case.

It is possible to locate some branches of manufacture where means for supplying power have been already established. This may be water power direct, or it may be water power transmitted to a city electrically, as proposed in connection with Niagara Falls, or a steam supply from a street system, or even a supply of power by belt in a building. For each of these cases the above table on the cost of steam power gives a fair idea of what the manufacturer can afford to pay. If the location for the manufactory to be operated by water power is between two canals of different elevations, and the manufacturer must put in his own canals, wheel pits and races, the cost of these should be considered in connection with the rental. If electricity is furnished, but not a motor, this cost and the consequent connections must be considered. These illustrations are sufficient to show the principle, but the question of reliability of supply, the certainty of doing work every day and hour in the year that it is required, must be considered in connection with the various other questions, such as adaptability of location, contiguity to markets, and rates of transportation.

The value of water power depends in general upon the reliability of the supply. A torrential stream running only at times during the fall, winter and early spring is, however, available for power purposes under certain conditions, if the cost of the plant can be kept down so that the question of interest is not of a serious character. Along such a stream the farmer's boys can get in their harvests in the dry season, get out and haul logs in the winter before the snow melts, and saw them by the water power when the stream is full. In such case, the labor having other occupation, is never idle, and a condition of things is possible which is impracticable under regular manufacturing conditions. The same condition of things can obtain on a small stream with a large millpond, if the miller has a farm or workbench to occupy his time while the millpond is filling up, the conditions being somewhat the same as for a windmill.

To determine the conditions under which water power is more advantageous than steam power, it is necessary to establish a basis of comparison. From considerations above stated it will be seen that the cost of steam power depends in part on the price of the fuel at the particular location, and in part on the cost of the maintenance and repair of the machinery required to produce the power, together with interest and dividends on the capital represented by the first cost of the plant. The cost of water power is represented by the interest on the cost of dams, canals, races, wheels, and means of transmission, together with the cost of maintenance and repair, but in addition, for most locations, contingent allowances must be made for damages from floods and ice and loss of profits from stoppages due to lack of water, injury to plant, etc. In most factories where power is derived from water, steam is also a necessity—at least for heat and various manufacturing purposes—and it is well known that the best way to utilize the power for variable streams is to provide duplicate plants for water and steam, in which case the saving due to the water power is represented chiefly by the cost of the fuel saved, and this is partly offset by the increased interest and maintenance charges due to the double plant. It will thus be seen that the mere fact that water from an elevated source is going to waste in large quantities does not necessarily mean that the power thereof can be utilized economically in comparison with power derived from a steam engine. A solution of the problem can only be obtained for each particular case. For illustration, we present a comparison we made some time ago in relation to the cost of water power on the Merrimack river.[3]

In that case the property at particular points has been developed by companies at a cost of at least $77 per horse power, and the lessees of the power had put in head gates, flumes, wheel pits, wheels and tail races, at a cost of $45 per horse power of wheels, or about $65 for each horse power utilized on the average throughout the year—making a total cost of $142 per horse power. "If we consider that accidents are liable to happen to the best constructed hydraulic work, we should charge at least 2½ per cent. of the original cost for depreciation—say 1¼ per cent. for repairs and about 1¼ per cent. for taxes, or about 5 per cent. in-

2- See Trans. of the Am. Soc. C.E., Vol. XII., Nov. 1883. See also Trans. Am. Inst. El. Eng'rs., Vol. IX., March, 1893.

3. See supplement of article in Trans. Inst. El. Engrs, previously referred to.

dependent of interest account. If, then, on the principles above developed, we charge 10 per cent. to an account for interest and dividends, and allow 2 per cent. for operating expenses, the total annual charge becomes 17 per cent. of the original expenditure."

Seventeen per cent. of $142 is $24.14, on which basis the cost of water power appears to be about the same as the cost of steam power with the most economical engine shown in the above table. The cost of coal on the Merrimack river, however, is greater than $3 per ton; so, on the basis discussed, steam power appears to be cheaper, and this conclusion is further emphasized by the fact that steam is required for other purposes in all the mills, and that heating, boiling, etc., can be done efficiently with exhaust steam. The power from engines furnishing exhaust steam is obtained at a nominal cost, as the heat in the exhaust steam can be charged to another account and amounts to about 85 per cent. of that taken from the boiler. From these considerations it would appear that there would now be no object in establishing cotton mills along the Merrimack, for mills built on the seaboard would have a decided advantage in the price of coal and in the transportation of raw materials and finished products. In a general sense the comparison is correct, for steam mills in Fall River do compete in the market with those having water power in that place and on the Merrimack. A more recent investigation of the subject developed, however, many reasons why the water powers on the Merrimack will never be abandoned, and some reasons even for rebuilding the same if destroyed. Although the water power is owned by a separate company at each place, the principal stockholders are the companies owning the mills. In most cases the business of furnishing the water has been very remunerative on account of original purchases of land upon which now stand large portions of cities. Moreover, with such an organization, the surplus profits paid for water power to the power company are really returned to the mill owners. It follows, therefore, that, if we consider the actual results by eliminating the independent company, the mill owners obtain their water power under quite advantageous conditions. Practically the cost to them is simply that of maintenance. The dam, canals and permanent structures were well built in the first place, and very little is required for keeping them in order. The same is true of the sub-canals, wheel pits and races at the several mills. The greatest item of cost is the renewal of the wheels themselves; so the cost to the mill owners in such a location is practically this last item, plus the cost of maintenance of permanent work, together with interest on an investment which itself pays a dividend and therefore pays such interest. Moreover, the rate of interest assumed is too large, if the property be considered as practically owned by one association. So also, for reasons stated, the large rate of depreciation named above should only apply to structures that wear out rapidly, like the wheels and gates. Such a modification of the items of interest and depreciation greatly reduces the cost of the power to mill owners. To determine an exact balance for a particular location would require an accurate knowledge of facts not entirely available, and the details in any case could not be discussed in this article, which is necessarily confined in the main to general principles.

From the above considerations it will be seen that an old established water power may be more valuable than a new one, for the reason that the stability of the permanent structures has been established by time, and a low rate of depreciation may be fixed by experience. No new company could build a large plant without providing for the various items of cost given above. If collateral profits are expected to meet the interest, they should be considered; and, if the work is well done, as it should be in every case, the rate for renewals stated above is too high for a long period of years, but for safety should be considered for a reasonable time to provide for an unexpected contingency. The safest way would be to put a definite percentage of the original cost of the plant each year in a sinking fund, and, when the sinking fund becomes large enough to pay for renewal of structures most likely to be destroyed by accident, it should be stopped, but kept at interest as an asset. Meanwhile a very low rate of depreciation can be charged against the remainder of the plant, so that the condition of the books is always on the safe side. It will be seen, therefore, that there are some important financial questions to be considered, and that a water power available for a long time may have a very great value, even when compared with steam engines under modern conditions. In deciding the questions for a particular case, a special investigation must be made, taking all considerations into account. There are locations where water power may be developed so cheaply that the principal question is to ascertain if it can be utilized. The answer, independent of the question of establishing a new city, largely depends upon the availabilty of proper means to transmit the power to cities and manufacturing establishments at a distance, or to points near mineral deposits, where power is desired. Wire rope transmissions are available for distances of a few miles, though generally limited to a few thousand feet. Air transmission is desirable for mining purposes, as the air discharged from the working cylinders assists in the ventilation of the mines. There are also some large installations in which air is used to transmit power several miles. The air is compressed with powerful pumps, becoming thereby heated to such an extent that it must be cooled artificially. This cooling represents a loss of energy, to which must be added the loss due to friction in the pipes and the losses due to the engine operated by the air. For these reasons the efficiency of air transmission is generally considered to be only 50 per cent. for short distances, and is generally less as the distance and number of points of supply are increased. Compressed air is used commercially in Paris on the Popp system, and Prof. Riedler has shown that the efficiency is materially increased by the use of reheaters, which to a greater or less extent restore the heat lost in compression, and thereby make the air operate more efficiently. Of late electrical transmission has come to the front, having been made practicable by the use of alternating electric currents of high tension.

Great interest was excited on this subject by the transmission of upward of 100-horse power a distance of 108 miles, from Lauffen to Frankfort, during the Electrical Exhibition at the latter place in 1891. The transmission was obtained with an efficiency of about 75 per cent. from the power delivered by the water wheel at one end to that delivered by the electric motor at the other. The resulting loss of 25 per cent. therefore included the losses in the generator and the motor, the line losses, and those due to step-up transformers at the transmitting end and step-down transformers at the receiving end; so the result, independent of capacity, was electrically and mechanically a great success. Further developments were checked for a time on account of the comparatively large cost of that installation, particularly in relation to the capacity actually obtained. Since then, however, the subject has been taken up by the principal electric companies here and abroad, and the cost of the work brought down to comparatively reasonable limits, so that, under its early advisers, the Cataract Construction Company apparently expected to be able to transmit and sell power in Buffalo for something like one-half the cost of steam power. Later developments, and perhaps the advice of the writer and others, called attention to the many features to be considered in developing such a problem, and as a result prices have been materially increased. There is no question but that water power may be obtained very economically under the conditions obtaining at Niagara Falls, and should be sold at very reasonable rates on the property of the Company. The question just how far it will be practicable to transmit the power electrically at a profit to the Company and with advantage to the consumer must be developed on a commercial basis of bargain and sale, the same as dealings in any more tangible commodity with the delays incident to such transactions.

No such questions arise in the mining regions of the West where coal is high priced. Quite a number of installations have been made in such localities, which are operating satisfactorily between points separated by considerable distances. Some water powers have also been developed at the East in the vicinity of cities, one notably at Sewall's Falls, on the Merrimack, near the city of Concord, N. H., where tri-phase alternating current electric generators at the Falls furnish corresponding electric currents which are distributed in the city for lighting and power purposes. The results of all the applications, though encouraging, are not yet sufficient to warrant the early realization of the dreams of the sanguine, that, ere long, all the cities of the country will be supplied with power, light and heat by electrical transmission from waterfalls and coal mines, but progress is being made rapidly, and developments as wonderful as those already achieved in the past may be reasonably expected in the future.

Interior Conduit and Interior Wiring.

By Mr. Charles E. Burton, before the Northwestern Electrical Association.

The business of manufacturing and selling electric current of the present day demands in the person of its executive qualifications that were formerly considered superfluous. Those in charge of an average central station, such as are found in most cities represented here, must combine in addition to qualifications of an executive and financial nature those of an electrical nature, certainly to an extent to be able to assign causes for certain results and to discern and anticipate results from certain causes. It is not infrequently the case that all details of an electrical nature are in charge of those who do not look with favor upon many innovations whose merits are not immediately apparent. I

assume that the members of this Association meet for the interchange of views relative to operative methods and for the procuring of such information as may be had. Further, that you regard your business as one of permanency, and all that tends to the betterment thereof increases its permanency. The cautious manager expends careful thought in the purchase and operation of the most economical generating devices, both steam and electric. The expense of producing a watt is most carefully scrutinized, and if possible, reduced; and when a month's record shows that this watt has been manufactured and delivered at the switchboard at a cost less than the preceding month, it is a matter for congratulation. This watt, which has possibly caused so much watchfulness to economically create, is now turned loose upon the wiring system to earn the cost of its generation and enough more to pay an interest on the investment.

But right here in many instances the surveillance seems to cease. If this watt meets with resistance in the overhead lines or finds a short path to the ground, the loss falls on the station. But if this result occurs on the inside of a motor, that is another matter, and the loss falls upon the customer; and it is the failure to regard this effect as much more than a joke on the customer that tends to establish strained relations between the electric light company and its customers, with a possible like effect on the net earnings. It is generally conceded that a majority of the interior wiring found in most cities is of a character that reflects little credit upon its author and less upon the light company who allow it to menace property by putting current through it. People not identified with electrical interests readily profess a dense ignorance of electrical matters; they regard it as a science acquired only by long and exhaustive application, hence are not capable of determining whether the wiring in their premises is of a safe character or not, trusting in the judgment of the local lighting company, and when an electric company consents to use interior wiring which they know to be of an inferior or unsafe character, they might be accused of playing a mild confidence game on their customers. The different companies writing fire risks upon structures of all kinds assert that inasmuch as they have assumed a liability by placing a line of insurance upon a building and its contents, that they shall control in a measure the property covered, indicate the hazards that exist and insist upon their correction. They have learned by costly experience that electric light companies as a rule are exceedingly negligent in the inspection of the internal wiring to which they attach their supplying conductors, and hence we have rules issued by the various underwriting associations, relating very minutely how all classes of wiring shall be installed, and we also have corps of inspectors in most cities whose duties consist of a systematic and rigid examination of wiring in all structures upon which insurance now exists, or is liable to be placed, and who have the power to insist upon the correction of existing evils or faults, or in the event of failure on the part of the assured to so correct them, make a rate proportionate, in their estimation, to the hazard incurred. It is not to the credit of electric light companies, or to the business of electric lighting, that the underwriters have been compelled to take the initiative steps toward the improvement of the electric light business. In reality there should be no underwriting rules. If the standard of electric wiring has fallen so low as to require the rigid inspection and supervision that is now exercised by the underwriters, the electric companies themselves should be the ones to protect their own interests in the provision of proper rules and regulations against the introduction of poor labor and material, and as the business has assumed the dignity of a permanent profession it is not right that the actions of its members should cause the necessity of such close surveillance by those who claim to have been injured by a lack of ability to conduct its business on a safe basis. We would think very poorly of a physician whose lack of ability was so apparent as to require the inspection of his prescriptions before we would consent to use them; and hence the conclusion can be inferred that if those supplying an electric current for use by the public, and knowing the damaging character of poorly installed interior conductors, had been more alert in the anticipation of results, and more exacting as to the quality of work performed, there would not have been the general distrust of the presence of electric current in a building, but would have been an increased approval of that method of service.

It is undoubtedly a fact that in many places electric lighting plants are instituted on a basis that precludes the possibility of the highest quality of work. The customers refuse to pay for it and the prices charged for service are so low as to render the highest grade of work almost prohibitory. It does not, however, mean that poor wiring can be used. It is far better to have a high grade system of exposed wiring than a low grade system of concealed wiring. The ideal method of wiring, looking at it with a view of greatest security and insulation, is exposed, heavily insulated wire, supported upon non-combustible insulators. This may do for factories and other places where exposed wires are not objectionable. Your customers, however, object to the presence of wires on their walls and ceilings, and naturally expect that the wire shall be placed in a manner that will be the least objectionable. But when it comes to concealing wires, it would appear to be the practice in some places to perform a quality of labor and use material that would not be tolerated if the wiring were to be exposed. Concealed work, in view of the fact that it cannot be inspected, or pending trouble seen, should in its varied nature be of a character that would preclude the possibility of any existing danger. It has been customary in work of this kind to bore holes through the joists, pulling the wires through these holes and supporting them upon anything that proves to be convenient. The insulating or fire-resisting qualities of these supports seem to have been a matter of little consideration.

In a recent report of fires from electrical sources it was reported that 71 fires were caused by short circuits in wirings, passing through or adjacent to wooden supports, and the present underwriting rules provide that all wires, whether concealed or exposed, when not run in interior conduit, must be supported wholly upon non-combustible insulators. This means that every hole through which a wire is passed must be previously bushed out with some insulating substance, such as metal-sheathed bushings, glass or porcelain. This method naturally increases the cost over the old method of wiring, but at the same time increases the security of the system. It has many disadvantages, however, that render it quite objectionable.

All concealed wiring should also be of a character that will secure the owner immunity from loss of current and protection from fire hazard. It should further be of a character that will enable its inspection at all times subsequent to its installation. Where interior conduit is not used this latter effect is rarely attained, and this brings us to the use of interior conduit for all classes of interior wiring. It is claimed that by the use of this conduit the objectionable features formerly found in concealed wiring have been eliminated. It gives to a system of wiring mechanical protection, additional insulation, and above all, the ability to withdraw and reinsert wires at any time without damage to the building or any of its decorations, should the insulation of the system become impaired.

It is probably useless to describe with any minuteness the interior conduit system, as it is to be hoped that it has been sufficiently advertised and presented to most of you, so that its good qualities have been readily understood. The system consists virtually in piping a building throughout with insulated pipes, thereby providing continued insulated raceways or channels for the reception of the wiring. The complete system provides, in addition to the conduit, various forms of junction, cut-out and outlet boxes; and all the various conditions of interior wiring have been met and provided for in this system.

Interior conduit is now furnished in three forms—the plain conduit, brass armored and iron armored. The plain conduit, which was the original form, is manufactured by building up tubes of special paper, the paper being wound on a mandril spirally and the different layers cemented together; after seasoning the tubes are boiled in preparations that render them impervious to moisture and practically fireproof. Many millions of feet of this kind have been installed, but to meet the demands of greater mechanical strength the brass armored conduit was introduced, which is simply the plain conduit having a sheathing of brass drawn over by special and ingenious machinery. The necessities and exacting conditions of modern construction demanded something having more mechanical strength than the existing types of conduit, hence to meet these requirements was brought out the iron conduit, which is the plain conduit forced into iron pipe in such manner as to secure a positive union of the conduit and the iron. This tube is built to fill all the requirements of flexibility and permanency desired by engineers, and is fast assuming the popularity that must be gratifying to manufacturers.

Interior conduit requires no arguments to secure the approval of architects and engineers; its advantages were apparent, but to secure its use by owners was a difficult matter. Most radical improvements or departures from existing methods require the expenditure of a large amount of labor and argument to secure their adoption. It is within the recollection of many of us when Underwriters' Insulated Wire was considered the ideal insulation, and the early manufacturers of rubber insulated wire were obliged to use very strong arguments to sell their product. Time has demonstrated the fact that the best insulation is none too good, hence we have the almost universal use of rubber-covered wires for inside wiring. Double-pointed tacks used to be used as insulators, but not in the present generation.

It was formerly considered good engineering to bury electric light conductors in or behind plastering, but it is not done in first class buildings to-day; interior conduit is used. In hundreds of places it is considered perfectly safe to run wires in an indiscriminate manner with no regard to the liability incurred; but time will demonstrate the fact that had interior conduit been used a great many of the existing evils would have been eliminated. The point has been and will continue to be raised by many that the cost of installation prohibits the use of this conduit. All improvements of any value cost money. Interior conduit costs money to purchase and install, but are not the advantages secured by its use a sufficient argument to secure its adoption?

Relative to the cost of installing interior conduit, it has been demonstrated in actual practice that it will require approximately an additional expenditure of 20 per cent. for plain conduit and 40 per cent. for brass conduit, these figures being based on the cost of installing interior conductors in the old method; that is, boring holes through the joist and with no regard to ordinary safety precautions: that if the wiring system is put in, in compliance with modern regulations—that is, the bushing of all holes with insulating material, and the wiring system being supported wholly upon non-combustible insulators. Interior conduit can be used at a cost averaging not more than 10 per cent. for plain conduit and 20 per cent. for brass armored conduit, in addition to the cost of the method last above noted. These figures, obtained from actual installation, are average figures, given by a number of contractors, who have installed wiring in both of the above noted methods.

The installation of this conduit is very easily accomplished; in fact, no previous experience is actually necessary beyond a few initial instructions as to the proper methods of making joints and economical methods of using the conduit. In a fireproof building the conduit is attached directly to the walls and ceilings by means of special clips or other devices, and in the case of plain and brass armored conduit is fully covered by finished plastering. In a wooden structure it is customary to channel the joist and lay the conduit directly in these holes; or, if plastering is furred out from the joist, convenient raceways will be found for the use of the conduit.

It is customary in most specifications to provide that the wiring shall not be pulled into the conduit until the building is practically completed. This provision is made so as to secure to the owner the continuity of tubing which is especially desirable to enable the proper subsequent manipulation of the system. If the contractor fails to make proper joints, it will be impossible to pull the wires through, hence this provision, the inference being that the contractor, to secure immunity from trouble in pulling in the wires, will be careful in the installation of the conduit. This also enables the owner at any time to withdraw these wires and insert others, should it become necessary. It also enables the owner to have his building piped for these conduits, and the electric conductors can be drawn in at such time as may be found convenient; or, if the electric current is not present near his premises at the time of construction, he can pull in such conductors as may be found necessary when the current is to be secured. The use of the various junction boxes and branch circuit boxes enhances the flexibility of the system, in that it provides covered receptacles for the cut-outs and also increases the accessibility of the system.

The advent of iron armored conduit has created something of a change in the methods of wiring. Formerly it was deemed advisable by underwriting associations to require that separate tubes should be provided for each conductor. In the case of the iron armored conduit and the use of an alternating electro-motive force, a compliance with this rule would manifestly be virtually impossible; the iron in the conduit having a choking or inductive effect upon the current passing through it; whereas, with the two conductors in one tube, this action was absent. Hence, taking this into consideration, and also the fact that a much greater mechanical strength was obtained than with former conduit, a ruling was made by the Underwriters' International Association, permitting the use of two conductors in a single tube of iron armored conduit.

This concession opens up a wide field for the use of iron conduit, and its effects are already apparent.

Practical installation has demonstrated this fact, that a building can be piped with iron armored conduit and the conductors placed therein at an expense less than would be incurred if brass armored conduit was used, using the double tube system. This statement may seem at variance with first impressions, but it is nevertheless a fact. The iron conduit is placed in a building in a manner similar to gas pipes, similar connections and unions being employed. There need be no fear of mechanical disturbance, as it is nail-proof, hammer-proof and wheelbarrow-proof, can be placed upon the floors or run in advance of construction, and the wires pulled in at the convenience of the electrical contractor.

In view of the fact that interior conduit meets with the approval of the underwriters as an ideal method of concealed permanently accessible construction, and meets the requirements of engineers as a permanent mechanical protection for interior wiring, we can but see for it a future of universal adoption. "Its law is progress; a point which yesterday was invisible is its goal to-day, and will be its starting point to-morrow."

Suggestions in Preparing Specifications for the Electric Lighting of Buildings.

Mr. Nelson W. Perry, E.M., is contributing a well put together series of articles, on the matter named in the heading, to the *Engineering Record;* and the author, in his third number of the series, which is devoted to the "Dynamo Room," deals with the following matters of interest to our readers:

The drawing of specifications for the power plant of an electric light installation involves such an intimate knowledge of the requirements of electric light service that none but those familiar with those requirements can hope to be successful. There is scarcely any other application of power in which the conditions favorable to the most economical operation of the prime mover are so fully departed from or so exacting in all respects as in the lighting station, or in less latitude which is allowable. Emery [1] has very clearly shown that in ordinary steam practice it makes really very little difference, so far as final economy is concerned, what type of engine is employed or what its efficiency may be when the expenses independent of the coal consumed are considered, and that the latter are fairly constant, independent of the type of engine, and that, without considering interest or dividends, they will in some cases equal the cost of the coal.

Such may be true in larger power plants, where the load is fairly constant for the day, but in small plants, such as those required in isolated lighting stations, the cost of attendance alone may equal that of the fuel. When we consider, too, that even in large electric lighting stations which supply greatly diversified demands whose several maxima tend to overlap each other, the maximum load frequently exceeds the mean load by 300 or 400 per cent., and this maximum load at best lasts but two or three hours out of the 24, we will appreciate the difficulty of economically meeting the conditions in an isolated plant where the maximum load lasts no longer, where the minimum load may be zero for 12 or 15 hours out of the 24, and where the cost of attendance may form such a large proportion of the whole expense. In the larger plant, divided up into a number of units of power, a considerable economy is effected by shutting down from time to time sufficient units to keep the remaining ones operating at full load. But, notwithstanding this, it is an ordinary condition of working in the most carefully operated central stations that the amount of extra fuel used, owing to the irregularity of the demand upon the boilers, is 43 per cent. in excess of what would be required if this cause of loss were abolished.

Isolated plants are seldom of sufficient size to warrant the subdivision of power, so that we cannot shut down a portion of our plant for the sake of economy at light load. Our boiler plant, steam engine and dynamo must all be of sufficient capacity to meet the maximum demand, and yet to meet the mean demand with as fair an economy as possible. To do this the fixed losses must be reduced to the lowest possible limit, even though by so doing we increase largely the charges at maximum load.

To illustrate how important these fixed losses become in the case of a variable load, let us suppose that we have an engine which indicates 100-horse power. Its brake horse power will be, say, 80. There will be a further loss of 20 horse power in belting to countershaft and from countershaft to dynamo pulley, making a total loss between piston and dynamo of 40 horse power, or 40 per cent. Suppose, now, the load be decreased so that the engine is called upon to indicate only 50 horse power; these losses being fixed, they will then constitute 80 per cent. of the total, and will form a larger percentage the smaller the engine. We therefore see the absolute necessity of reducing these fixed losses, and to do this must abolish belting and shafting so far as it is possible to do it.

An ideal method of driving the dynamo would therefore be to connect it directly to the engine shaft without intermediate gear, and this is now becoming the universal practice in central stations. It postulates high-speed engines, because it is cheaper to build dynamos for

1. "Emery on Steam Power," *Transactions* American Institute of Electrical Engineers, Vol. X.

high speed than equivalent ones of the same output at low speed. But the objection of higher cost per unit of output of low-speed generators is becoming less and less every day, and the practical limit of low speed which may be attained for a given output is that at which the interest on the increased cost of such a dynamo overbalances the advantages gained thereby. The idea that a dynamo to do good work must run at high speed is a popular fallacy that has long since been exploded. If only we use enough material in its construction, we may make the speed for any output as low as we choose. With small units, however, the cost of machines operating with decreasing speeds increases in such a rapid ratio that we are thus constrained in such cases to resort to intermediate gear rather than to further reduce the speed of the armature. Just where to draw the line it is difficult to lay down any hard and fast rule, but generally speaking it is safe to say that it is perfectly feasible to operate dynamos as small as 15 to 20 kilowatt output, requiring engines of 24 and 31-horse power capacity to drive them by direct connection, since these involve speeds of about 550 and 450 revolutions, to which dynamos now in the market already conform. But if still slower speed be desirable, as many will contend, the cost of dynamo will be considerably increased. To illustrate at what expense this slower speed may be attained, it may be stated that a 20 kilowatt machine running at, say, 550 revolutions, may be so wound as to give 12 kilowatts at 200 revolutions per minute. The slower speed would therefore make the machine cost just about twice as much per kilowatt as the same machine at the more rapid speed. There are probably few cases, however, where it would not be better to pay the increased first cost necessary to bring the machine down to the engine speed than to incur the constant loss of 10 per cent. or more involved in belt transmission.

But this direct connection of dynamo to engine involves the greatest nicety of speed regulation in the engine. Variations in speed which would be allowable in belted engines will be wholly inadmissible where they are direct connected. The usual governor regulation which will keep the variation of speed of the engine between no load and full load within 1 per cent. is essential, and should be insisted upon; but this is not all. To this must be added adequate flywheel capacity to take care of the instantaneous variations too rapid to be taken care of by mechanical governors. It is these minor variations in speed of the engine which, if not overcome by sufficient flywheel capacity, cause the annoying flickering so trying to the eyes, observed more especially in small lighting plants, but also not infrequently on lights supplied from the street circuits.

Where economy of space is necessary, and in fact in many other situations, the gas or gasoline engine recommends itself. In the first place, it requires no boiler or coal room, is practically free from dirt, as there are no ashes to remove, it may be started up or stopped at a moment's notice, and involves the consumption of no fuel during either of these operations. In the smaller sizes its efficiency is considerably higher than the steam engine of the same size. In fact, on account of its high thermal efficiency, which exceeds that of any but the triple and quadruple expansion steam engines, it surpasses even in the small sizes, 5 to 30-horse power, in point of efficiency all but the largest and most expensive steam engines. It possesses also another marked advantage over the steam engine in that it requires almost no skilled attendance. There are many private lighting plants in Germany and England, and also not a few in this country, operated by gas or gasoline engines, which receive no attention whatever except such as can be given them by the help ordinarily employed around a gentleman's residence or by the porter in his place of business.

These engines are made in all sizes up to 250 horse-power, but it is my opinion that in the larger sizes the advantages over the steam engine of the same size which the smaller ones possess largely disappear. One difficulty which is met with in the larger sizes (from 75 horse-power upward) is that an auxiliary steam engine is required to start them. In the smaller sizes, however, this is readily accomplished by hand, and up to 15 or 20 horse-power may be done by a boy or a servant girl. Any of the leading manufacturers of these engines will guarantee the production of an actual brake horse-power when the engine is running at full load with a consumption of 20 cubic feet of ordinary city illuminating gas per hour, which at $1.50 per 1,000 cubic feet makes a cost but 3 cents per horse-power. With 75° gasoline, the consumption will be about one pint per hour—often less. It is needless to say that no such figures can be obtained from small steam engines.

These economies do not extend to the cost of installation, however, for the smaller sizes of gas engines cost as much per horse-power as the steam engine and boiler plant combined do. Thus a five horse-power indicated (four horse-power actual) costs to-day f, o, b at the factory $400, or $100 per actual horse-power, and a 55 horse-power indicated (50 horse-power actual) costs $2,300, or $56 per actual horse-power. This exorbitant price for small engines has greatly militated against their more general adoption in this country.

The gas engine is not susceptible of the close governing necessary to direct connection with dynamos for lighting purposes, so that some mediary between the engine and the lights is absolutely essential to steadiness of the latter. This intermediary may be either a belt or a storage battery. All of the best known gas engines work on what is known as the Otto cycle, or some modification of the same, and depend for regulation of speed upon a proportioning of the number of explosions to the load. Thus as the load decreases, the number of explosions, and consequently the number of impulses imparted to the moving mechanism, decreases, and the motion becomes more and more irregular. Very large flywheel capacity, therefore, becomes necessary on the engine, and if it be employed to drive a dynamo by belt, a flywheel should also be placed on the armature shaft. Some manufacturers recommend in their circulars the use of a countershaft and the placing of the extra flywheel there rather than upon the armature shaft. The writer has already expressed himself as strongly opposed to the use of countershafting under any conditions where it can be avoided, but even if countershafting should be necessary, the flywheel will be much more effective on the armature shaft than upon the countershaft.

Gas engines are now made for lighting purposes with two flywheels, and these when belted to a dynamo, with additional flywheel, give a very steady light, even with partial load down to one-half. At that point the lights become more or less unsteady. Even this may be overcome by heavier flywheels, and in drawing specifications, where it is desired to leave the contractor some latitude in the choice of engines, it will be specific enough to require that the lamps shall not flicker perceptibly to the eye when running at mean load (whatever that may in the particular case prove to be.)

The gas engine is open to another objection not so pronounced in the steam engine—viz., unless it is especially provided against, it is very noisy. If the exhaust is made directly into the open air of the engine-room, it may be heard on the floors above, and if in a block of residences in the city by the neighbors also to such an extent as to become a nuisance. This can be very largely overcome, however, by leading the exhaust into muffled chambers, and thence discharging into the chimney or flue. If this is properly done, the noise will not be obtrusive even in the engine-room, and will not be heard at all on the floor above, or even in an adjoining room when the door is closed. This is a point that should be rigorously insisted upon in all gas or gasoline engine installations, and the specifications should be so closely drawn as to leave the contractor absolutely no avenue of escape.

The other intermediary by which regularity of light may be obtained is the storage battery. There are also other questions involved here which may be even more controlling than that of mere light regulation which will determine the use or non-use of the storage battery in any particular case, and these apply with equal force whether steam or gas engines are employed as prime movers.

In the first place the storage battery plant will cost as much or more—usually more than the steam or gas engine plant, including the dynamo. It involves the necessary fixed loss in addition to those of the engine, dynamo, belt and electrical transmission of at least 20 per cent. when the batteries are new and more when they are old, and they are subject to deterioration which cannot be reckoned on at less than 10 per cent. per annum. I place the deterioration at 10 per cent., because the manufacturers are now willing to insure their batteries for that figure; but this should be clearly insisted upon in the specifications, for if the batteries be too small, or if they are not of the best make or do not receive the proper care, they may greatly exceed this figure. I may say, however, that if the batteries are large enough and receive half-way intelligent care, their deterioration will be considerably less than this.

On the other hand, the storage battery, when once charged, gives a very uniform current and one entirely devoid of sudden fluctuations affecting the light, however irregularly the engine or dynamo may run. It permits the employment of considerably smaller engine and dynamo than would be required for the maximum demands and permits of the operation of these latter at their most economical rate.

For residences the maximum demand for light rarely exceeds 3 hours out of the 24, and but few lights are ever required all night and none in the daytime. If a 9-horse power engine were required to supply the maximum demand it would usually be perfectly safe to install 4-horse power with the storage battery. In office buildings the maximum demand might last 4 or 5 hours, say from 5 to 9 or 10 P.M. After 11 or 12

P.M., perhaps the only lights required would be those in the hallways—not enough to pay for running the engine. With the storage battery, perhaps half the generating capacity, if run during the daylight hours, would be sufficient to charge up for the whole 24. It is by economies of this kind that the storage battery recommends itself. It renders the light independent of the operation of the engine; and, although it involves a very much greater first outlay, and in most cases a somewhat increased operating expense, it gives incomparably better service than can be obtained in any other way from small or medium plants.

The question arises with every new building of medium size: Which will be the more economical, to install and operate a private lighting plant, or to buy the service from the lighting company? There has been no question in regard to larger establishments, such as hotels, theaters, modern office buildings and the like; but when it comes to installations less pretentious in point of size, the agreement has not been so unanimous. After having given the subject of lighting private residences some considerable study, I feel perfectly safe in saying that, where the power plant does not require the attention of help other than that already required about the premises for other purposes, it will be cheaper to generate one's own current. This will apply to demands as small as those made by the average country residence of from 12 to 15 rooms. It is based on the fact that wherever the supply comes from, the owner must furnish his own wiring and fixtures, and the question is whether he can supply his own power more cheaply than he can buy it. Gas engines as small as 4-horse power can be obtained in the market that will produce an actual horse power at full load with an expenditure not to exceed 23 cubic feet of gas, and at half load, not to exceed 30 cubic feet. If we should allow a consumption of 40 cubic feet to the horse power, and gas cost $1.50 per 1,000 cubic feet, the cost per horse power would be 6 cents per hour. It is customary to reckon 10 incandescent lights of 16-candle power each per horse power, which would make the cost $\frac{6}{10}$ cent per light. Gas burned direct in the ordinary burner would cost, allowing 5 cubic feet per 16-candle power burner, $\frac{1}{2}$ cent per light. The charges for electric light are usually 1 cent per light per hour. The above figures are, I am sure, sufficiently liberal to cover all contingencies, and are nearly double what some plants I am familiar with are actually producing light for in New York to-day.

The statement that light can be produced more cheaply from gas through the intermediary of the gas engine, dynamo and incandescent lamp than it can by burning it directly in an ordinary gas burner, will be received with incredulity by many, but it is a fact which is being daily demonstrated in practice, and is susceptible of demonstration on purely theoretical grounds. It depends for its truth on the far greater light efficiency of the incandescent electric lamp over that of the gas burner. Professor Tyndall has shown that the luminous radiations from an ordinary gas burner form only $\frac{31}{1000}$ of 1 per cent. of the total; or, in other words, that by burning gas direct for illuminating purposes we actually throw away, so far as useful purposes are concerned, nearly 99.7 per cent. of the total available energy in the gas. On the other hand, tests made at Cornell University show that a gas engine in so small a size as 6 nominal horse power has a thermal efficiency of 20 per cent. and a mechanical efficiency of over 80 per cent. at full load. Dynamos of the same size should have an efficiency of 85 per cent. (in larger sizes 95 per cent.). The transmission by belt in driving should be 90 per cent., and the electrical distribution to the lamps can be made anything we choose. Usually 2 per cent. loss in house wiring is allowable. This would give an efficiency of 98 per cent. The incandescent electric lamp, using 3.5 watts per candle power, has an efficiency of about 6 per cent. (2.5-watt lamps, with an efficiency of between 7 and 8 per cent., are now in the market). The ultimate or final efficiency therefore from the gas to the electric light will be 20 p. ct. × 80 p. ct. × 85p. ct. × 90 p. ct. × 95 p. ct. × 6 = 0.72 per cent., or, notwithstanding all the losses involved in the various transmissions and transformations, leaving still a ratio in favor of the gas engine of

$$\frac{720}{317} = 2.27 : 1.$$

This means that for every light produced by burning direct there can be produced 2.27 lamps of equal power by burning the same gas in a gas engine and causing it to produce electric light by means of the incandescent lamp. If the electric current be used to operate arc lamps the economy will be far greater.

But where, in a given installation, it is found necessary to engage especial attendance for the care of the apparatus, or to charge up a portion of the expense of attendance otherwise partially employed, it becomes a question among how many lamp hours this cost of attendance can be divided, whether the private plant or street service will be the more economical.

Let us suppose that we find our light can be produced at a cost of .6 cent per lamp hour without attendance, and that we have to pay a man $2.50 per day to look after the plant. Street service costs 1 cent for electrical and .75 cent for gas lighting. To compete with the street service, allowing each burner to be in operation four hours per day, we must have an average of 156 lamps in daily demand for electricity and 417 to compete with gas. In the above calculation the storage battery is not considered. It would add a further decrement in the chain of efficiencies, but it would reduce the attendance cost in this way, that by making the batteries of sufficient size, they need only be charged once in two or three days, thus dividing the attendance charges by 2 or 3, as the case may be.

Now, as to the systems of distribution between which we must decide. The series system in a private plant may at once be considered out of the question. The alternating current system need not be considered either, so far as our dynamos are concerned, for its province is in the field of wide distribution, where high potentials are necessary to economy. The alternating current is never admitted, is not permitted inside of the structure at its high potential, but is reduced down by means of transformers outside of the building to the potentials suitable for lamps. It is considered advisable in many cases, such as in public buildings, to provide for connection with the street mains in case of the failure of the private plant at any time. Where such provision is deemed desirable, the wiring should be calculated for the additional copper required by the alternating current; but usually the factor of safety allowed in direct current wiring will be ample to permit the utilization of the alternating current with safety.

As far as our generating plant is concerned we are therefore practically limited to a choice between the 3-wire and 2-wire methods. In isolated plants, where the distances to which the current must be carried are small, the saving in copper effected by the 3-wire system can seldom be sufficient to warrant the extra cost of the second dynamo involved, so that the ordinary direct current 2-wire system is the one usually to be chosen. It may, however, be necessary to provide for street service, and if this be on the 3-wire system it involves the wiring of the building in the same way, as no company furnishing current by this system would supply a large establishment from one side of its circuit alone on account of its unbalancing effect on the system as a whole. It is perfectly practicable, however, to wire the building on the 3-wire system for street connections and to use this wiring as a 2-wire system when connected up with the house plant. This is done by connecting the two outside wires of the 3-wire system together and to one terminal of the dynamo and the middle or neutral wire to the other. In laying out a 3-wire system with this end in view it will be necessary to give the neutral wire a carrying capacity equal to that of *both* the outside wires, for it has to carry the currents of both.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

In answer to a correspondent, who desired to know something more about the newly incorporated Watchung (N. J.) Gas Company than that afforded by our mention of a week ago, we present the following: The incorporators are: Sylvanus Ayres, Jr., of Bound Brook; J. Perry Griffin, of Cranford; Leopold Balbach, of Newark; Albert H. Crane, of Bayonne; Charles L. Knapp and Frank H. Cole, of Somerville; Franklin Noble, of Jersey City, and J. D. Thompson, John A. Wallace, E. A. Knapp, John H. Cole, M. E. Knapp and Franklin Everhart, of New York city. The projectors say that the object of the Company is to furnish fuel and illuminating gas to all towns along the Watchung hills, which, to say the least, is very indefinite, for there are many such towns, some of which are now supplied with gas while others are not. It may be possible that the movement hinges on the proposed consolidation of the two Newark Companies; but, in any event, some time must elapse ere the projectors of the Watchung Company will have it sufficiently developed to be ready to disclose the real meaning of the enterprise.

At a special meeting of the Board of Directors of the Newburyport (Mass.) Gas and Electric Company, held on the morning of January 30th, the following resolutions respecting the Hon. Eben F. Stone (who died some days ago), President of the Company, were adopted:

Voted, That in the death of our friend and associate, our late President, the Honorable Eben F. Stone, a service of more than 40 years speaks more than any words of the esteem in which he was held, and the confidence had in him for ability and integrity.

Voted, That this vote be entered upon our records, and a copy of the

same be sent to the family, with the sympathy of this Board, in their great bereavement.

MR. WM. R. JOHNSON has been elected President of the Newburyport (Mass.) Gas and Electric Company, vice the Hon. Eben F. Stone.

THE Gas Light and Coke Company, of London, England, has abolished all meter rentals throughout its district, the policy having been made effective on January 1, 1895.

THE Charlestown (Mass.) Gas and Electric Company has named the following executive management for the ensuing year: Directors, Jas. F. Hunnewell, James A. Sawtell, L. B. Hatton, Mark F. Burns, Chas. F. Byam, John Turner and Joseph Stone; President, Jas. F. Hunnewell; Clerk and Treasurer, George B. Neal.

A BUILDING on Hanover street, below Uhler's alley, Baltimore, Md., which is being demolished to make room for a more pretentious structure, is noteworthy as the first house in that city in which the piping for the gas supply was covered in by the walls and floors, as against the practice theretofore in vogue, having the piping unconcealed. The house was erected in 1835, by Mr. John Needles, a prominent cabinet-maker of Baltimore, and the service pipes throughout the structure were of copper.

MR. M. G. STRATTON, for four years past assistant electrician to the Lawrence (Mass.) Gas Company, resigned that berth to accept a place in Washington, D. C.

AT the annual meeting of the Berlin Iron Bridge Company, the following Board of Directors was elected: Charles M. Jarvis, George H. Sage and Burr K. Field, of Berlin, Conn.; S. Howard Wilcox, of Brooklyn, N. Y.; Julius Burr, of East Berlin, Conn., and H. Peck, of Waterbury, Conn. It was resolved to increase the capital stock from $300,000 to $500,000, all of which issue was purchased by shareholders of record.

THE annual meeting of the shareholders in the Shenandoah (Pa.) Gas Light, the Shenandoah Electric Illuminating and the Shenandoah Heat and Power Companies, resulted in the election of the following officers: Directors, S. A. Beddall, P. J. Gaughan, L. J. Wilkinson, H. A. Swalm, J. M. Robbins, George W. Beddall, J. S. Callen, H. W. Titman and J. S. Kistler; President, J. S. Kistler; Treasurer, George W. Beddall; Secretary, Robert Dengler; Superintendent and Collector, E. Anstock.

THE text of the decision of the Massachusetts Board of Gas and Electric Light Commissioners in the matter of the application of the Natick Gas and Electric Company for the right to increase the capital stock is as follows: "This was an application by the Natick Gas and Electric Company for the approval by the Board of an issue of stock and bonds to the amount of $250,000. This corporation does not yet own or operate a plant for gas or electric lighting, but has been duly organized and received its charter on the 15th of January, 1895. The purpose of this corporation is declared to be to acquire the property and franchises of the Natick Electric Company and the Eliot Falls Electric Light Company, and to manufacture and sell electricity for light, heat and power. It appeared from the Company's petition as originally filed, that the stock and bonds asked for were to be used for the purchase of the assets of the Natick Gas Company in addition to the property of the Companies named in the charter, and also to defray the cost of such alterations and additions as might become necessary for the joint operation of the two electric plants. This petition was subsequently amended by admitting the Natick Gas Company and reducing the amount of securities prayed for to $220,000, of which one-half should be bonds. The Natick Electric Company has been engaged in the supply of electric light and power for public and private use in the towns of Natick and Wayland since the summer of 1889. Its station is located in the central portion of the former town, and its entire plant appears, from the returns filed in this office, to have cost about $190,000. A reference to the books of the Company discloses that a large share of the present plant was purchased at prices above the current market rates, and that nothing has been charged off for depreciation except about $1,200 in 1890. The Eliot Falls Company does not sell light in Natick, but its principal business is the supply of current for the street lighting plant owned by the towns of Needham and Wellesley, with both of which it has contracts for a term of years. From the returns made to this office the cost of this property appears to be about $110,000, but a large part of this was purchased by the Company, with its common stock taken at par, this corporation being organized under the laws of another State. On the application of the Natick Gas and Electric Company for the approval of an issue of new capital to the amount of $125,000 stock and $125,000 bonds, it is ordered that the Board hereby approves of the issue by the Natick Gas and Electric Company, in conformity with all the requirements of law relating thereto, of 620 shares of new capital stock of the par value of $100 each, and of bonds to an amount not exceeding $57,000 at not less than par and accrued interest at a rate not exceeding 6 per cent. per annum, said stock and bonds, or the proceeds thereof, to be applied to the purposes designated by the Board and no other."

MR. S. WARREN SNEDEN, formerly prominent in the Directorate of the Nassau Gas Light Company, of Brooklyn, N.Y., died at his home in that city on the night of the 3d inst. He was in his 78th year, and had been concerned in the political affairs of Brooklyn.

THE proprietors of the Schenectady (N. Y.) Gas Light Company have placed the contract for the roof of their new generating house with the Berlin Iron Bridge Company, of East Berlin, Conn.

THE Committee on Lighting Streets of the Newburyport (Mass.) City Council has contracted with the Newburyport Gas and Electric Company for the lighting of the streets for the ensuing year. The terms are: Candle value, 1,200; lighting schedule, all "dark nights, from sunset to 1:15 A.M.;" price per annum, $73.50 per lamp—a concession of $1.50 from the rate of last year.

IT is reported that the works of the Great Barrington (Mass.) Gas Light Company will be shut down.

MR. O. H. HINDS is now in charge of the gas plant at Le Mars, Iowa, and we believe that he proposes to sensibly enlarge its capacity.

THE Erie (Pa.) Council, in joint session, recently awarded a contract to the Erie Gas Company, under which the latter will maintain 475 gas lamps on the public streets. The rate per annum agreed upon is $21.05 per lamp, which rate includes keeping in repair, lighting and extinguishing. The lighting schedule is about 4,000 hours.

THE annual report of the Inspector of Gas and Illuminating Oils for Baltimore, Md., shows that the gas supplied by the Consolidated Gas Company of that city during the past year averaged 27.16 candle value, or 7.16 candles above the statutory requirement.

THE proprietors of the Yonkers (N. Y.) Gas Light Company have definitely determined to extend their main system on the east to the village of Woodlawn, which place is but a short distance south of Mount Vernon.

THE Directors elected by the shareholders of the New York and East River Gas Company, at the annual meeting held the last week in January, comprise the following: August Belmont, Frederic Cromwell, Charles F. Cutler, Robert Goelet, G. C. Haven, H. B. Hollins, Emerson McMillin, Emanuel Lehman, R. T. Wilson, R. S. Hayes, A. D. Juillard and H. H. Rogers; Secretary, George C. Haven, Jr.; Assistant Secretary and Treasurer, S. L. Cromwell.

THE Board of Gas and Electric Light Commissioners has approved the application of the Lexington (Mass.) Gas Light Company for the right to issue bonds in the sum of $7,000, the proceeds to be applied to funding its floating debts. The bonds are to run for 20 years, and the interest rate is not to exceed 6 per cent.

THE election for Directors in the East Chester Gas Light Company, of Mount Vernon, N. Y., and the New Rochelle (N. Y.) Gas and Fuel Company, both of which properties are operated by the American Gas Company, of Philadelphia, resulted as follows: William Carpender, Edmund Penfold, Francis Crawley, Morris W. Stroud and George G. Ramsdell.

THE business offices of the Dallas (Texas) Gas and Fuel Company have been removed to 261 Main street.

MR. HOWE, of Marlboro, has brought forward a bill in the Massachusetts Legislature to increase the salaries of the members of the Board of Gas and Electric Light Commissioners. If the measure becomes a law the Chairman of the Board will be paid $5,000 per annum, and his associates $3,500 each.

THE gas consumers of Pittston, Pa., are complaining over the quality and price of the article supplied them by the Pittston Gas Light Company.

MR. WM. K. PARK, Chief Engineer of the Philadelphia Municipal Gas Works, in his report of the operation of the same for the past year, notes that the receipts of the year from all sources amounted to $3,143,431.29, leaving a deficiency of $136,921.60. This deficiency, however, is explained by the fact that all gas consumed by the municipality at no cost to the city is not credited to the Bureau, but stands as a loss, and by the statement that at the beginning of last year a reduction of 33⅓ per cent. was made in the gas rate—from $1.50 to $1 per 1,000. While the works were called upon to make from 10 to 15 per cent. more gas than was made during the corresponding periods in previous years, the manufacturing capacity was at no time taxed. The same thing, however, could not be said of the means for getting the product to the consumer. The inefficiency in this regard was particularly noticeable in the early hours of the evening, just at the time when ample illumination is most needed during the season of heaviest consumption. The yield of gas was 4.77 cubic feet to the pound of coal carbonized, and the candle power was 19.37, an increase in both respects over 1893. During the year, 47.03 miles of main pipe were laid. Complaints of a short supply of gas were numerous, and, unfortunately, came from a locality where a remedy could not be applied. The figures in the leakage accounts have assumed unusual proportions, the responsibilities for which rest with the many thousands of services not in use; with the renewal of main pipes and services along the routes of trolley lines of railway; with the numerous breaks in main pipes, which resulted from the introduction of other street improvements, and with the condensation in the mains resulting from excessive friction following an increased pressure necessary to get the gas into and through nearly 900 miles of small pipe. Even with the pressure carried it was utterly impossible to supply the demand, and this condition must continue so long as the request for larger mains is unheeded. The gas manufactured during the year was 4,110,401,000 cubic feet, of which 2,605,278,000 cubic feet are to be credited to the coal plant, and 1,505,123,000 cubic feet to the water gas plant on the 25th Ward works. The total quantity made since the erection of the works was 75,767,878,000 cubic feet.

MR. GEO. A. FARWELL, Supt. of the Waukesha (Wis.) American Gas Company, gave a very entertaining discussion before a large audience of Waukesha's solid men and fair housekeepers, the discussion being brought off in the lecture room of the Union School, towards the close of January. Mr. Farwell's theme was the history, manufacture and distribution of gas, which, of course, the speaker treated in a popular rather than a technical way. Not the least interesting chapters of his discourse, all of which was entertaining and instructive, were devoted to a consideration of the gas meter and to a description of the Welsbach burner.

THE proprietors of the Jamaica Plain (Mass.) Gas Company have just paid a dividend of 5 per cent., making the return for the twelvemonth equal 10 per cent.

A BILL is now before the Massachusetts Senate which proposes to authorize the Springfield Gas Light Company to hold real estate and to lay pipes for the furnishing of gas to the town of West Springfield.

THE death of Mr. Hirsch, late of the firm of Bradbury & Hirsch, of Liverpool, England, large factors in the sale of sulphate of ammonia, is announced.

THE Farrel Foundry and Machine Company, of Ansonia, Conn., has determined to build a new roll and machine shop, and the contract for the construction of the same has been placed with the Berlin Iron Bridge Company, of East Berlin, Conn. The building, which is to be constructed entirely of iron, brick and glass, is to have a width of 104 feet and a length of 260 feet. The roof will be of copper.

IT is thought that the new gas plant at Stoneham, Mass., will be ready for operating by February 21st. The Manager of the Company is Mr. Charles H. Patch, and the Company's application to the Board of Gas and Electric Light Commissioners for permission to issue $50,000 is now under consideration.

As is well known, natural gas has for some time been brought into Buffalo, N.Y., from the Canada side, through mains laid under the Niagara river, and that the United States has been collecting an import tax of 10 per cent. *ad valorem* from it, the action being based upon a general provision in the schedules that all non-enumerated unmanufactured articles shall pay such a duty. The Company which distributed the gas in Buffalo filed protests against the payment of the tax, claiming exemption (1) on the ground that natural gas is not an article of commerce within the meaning of the tariff; (2) as crude bitumen, under paragraph 496; and (3) as a crude mineral, under paragraph 651. After a lengthy investigation before the Board of General Appraisers, New York City, and other examinations in Washington, D. C., during which expert chemists and well known geologists gave evidence, the Board decided that natural gas is a crude mineral, and, as such, is entitled to free entry. The Government has appealed from this decision, and the matter is to come before the courts in the regular way.

AT the annual meeting of the Springfield (Mass.) Gas Light Company, the only change in the Board of Directors was the naming of Mr. Charles L. Goodhue to the vacancy occasioned by the death of Mr. Samuel Porter.

THE officers chosen by the Malden and Melrose (Mass.) Gas Light Company for the ensuing year are: President, Geo. W. Walker; Clerk and Treasurer, Vinton W. Mason; Directors, Geo. W. Walker, W. B. Buckminster, E. A. Hildreth, Geo. D. Bill, S. B. Hildreth, Daniel Russell, L. P. True, V. W. Mason, F. E. Chandler and Jas. H. Converse.

MR. E. H. JENKINS reports that he has displaced many electric lamps in Columbus, Ga., with gas lamps of the Welsbach type. One of the Columbus storekeepers (Mr. A. B. Daniel) writes: "I am very much pleased with the Welsbach light in my store. They cost considerably less than electric lights and give a great deal better light."

AT the annual meeting of the Stafford Springs (Conn.) Gas and Electric Light Company the officers elected were: President, D. S. Palmer; Vice-President, ex-Senator E. C. Pinney; Secretary, A. M. Young; Treasurer, N. D. Grannis.

THE Newton (Kas.) Light and Power Company has been incorporated by Messrs. J. B. Gentry, John A. Bailey, John C. and J. D. Nicholson and Robert Daugherty.

Arc Light Dangers.

A contemporary says that over the street doors of one of our most extensively patronized dry goods stores arc lights are suspended for purposes of illumination. Throngs of ladies are constantly passing to and fro under these lights. We noticed a narrow escape for a lady the other evening. Fire fell from the arc lamp and just grazed her dress as she passed under the lamp. The inflammable nature of womens' apparel is such as to render it dangerous for them to stand or pass under arc lights. There should be a law to prohibit the use of open arc lights. It would be easy to arrange a glass basin or plate under the lamp to catch and arrest any falling bits of the ignited carbon.

A 320-Horse Power Gas Engine.

Engineering Magazine says that if anyone has supposed the gas engine is not liable to become a powerful rival of the stationary steam engine, a description of a 320-horse power Simplex motor, as installed in a flour mill at Pantin France, will probably rectify such an opinion. *The Engineer* (Nov. 30), in which the machine is illustrated and described, regards it as an illustration of "the certainty with which the steam engine is being replaced for mill work, though slowly, by the more economical gas engine;" and it adds that M. M. de la Mare, of Debouteville, France, as also Matter & Co., of Rouen, builders of the kind of engine under consideration, "believe that they now see their way to the construction of 500-horse power gas engines."

The gas for the machine is made in Buire-Lencauchez two part gas producers, the two parts being coupled so that either can be used independently in cleaning and firing.

In a series of tests the following results were obtained. The diagrams taken from time to time gave a maximum of 280-horse power, corresponding, it is stated, by reference to other experience, to 220-brake horse power.

The gross consumption of coal per indicated horse power—no deduction being made for cinders or ash—was 0.788 pounds per French horse power and 0.803 pounds per British horse power; which represents, also, 1.028 pounds per French brake horse power, or 1.043 pounds per British brake horse power. In this trial 3,000 liters of water were consumed per hour for washing the gas, and 6,100 liters for jacket cooling.

It is claimed that the Buire-Lencauchez gas producers have obviated the hitherto existing necessity for using anthracite coal (almost any kind of coal being now available), and that thus the cost of producer gas has been much reduced. This advance is considered as insuring the final supremacy of the gas engine over all other stationary motors.

THE AMERICAN GAS LIGHT JOURNAL

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EDITOR—Jos. R. Thomas, C.E.
ASST. EDITOR—T. J. Cunningham.
MANAGER—C. E. Sanderson.

PUBLISHED ON EACH MONDAY OF THE YEAR AT
No. 32 Pine Street, New York.

TERMS:
SUBSCRIPTION—Three Dollars per annum, in advance. Single copies, 10 Cents.

This is a recognized official organ of
LIGHT, HEAT, STEAM, WATER SUPPLY, VENTILATION, SANITARY IMPROVEMENT, AND GENERAL SCIENCE.

AGENTS:
New York—American News Co., 39 and 41 Chambers St.
Germany—B. Westermann & Co., of New York.

MONDAY, FEBRUARY 11, 1895.

The Market for Gas Securities.

Consolidated was in better demand during the week, at prices considerably above those of the average for the last half of January. To-day (Friday) the bid price was 128, holders asking 129¼. The impression generally prevailing is that legislation reducing gas rates will not be pressed; but our own views look to an entirely different conclusion. We know that Senator Coffey, of Kings, is earnest in his struggle for dollar gas for Brooklyn, for he probably argues that a popular measure of this kind will cause many of his constituents to believe that a man who could afford them such relief must have much good in him. It is also pretty well understood that the Senator is not interested in gas stocks as a holder thereof. However, it is early in the day yet to say anything positive about what will be done in Albany. New York and East River common is at 24 bid, and there is no doubt it will go higher.

The Brooklyn situation is as before, and nominal quotations are unchanged. Bay State is very weak, at 19¼ bid, Chicago gas is steady at 75½ to 75¾, and Baltimore Consolidated is in better demand, at 63 bid.

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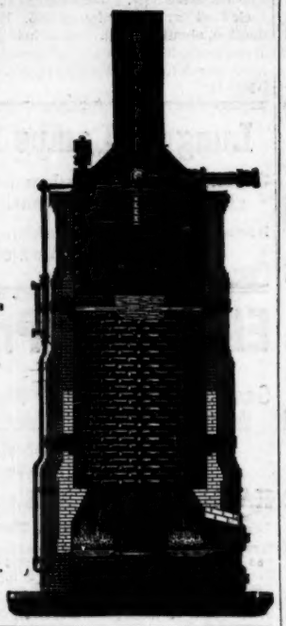

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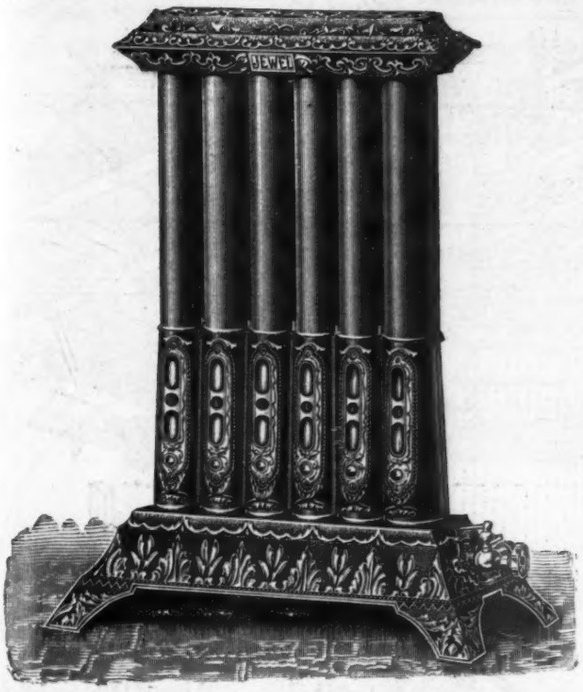

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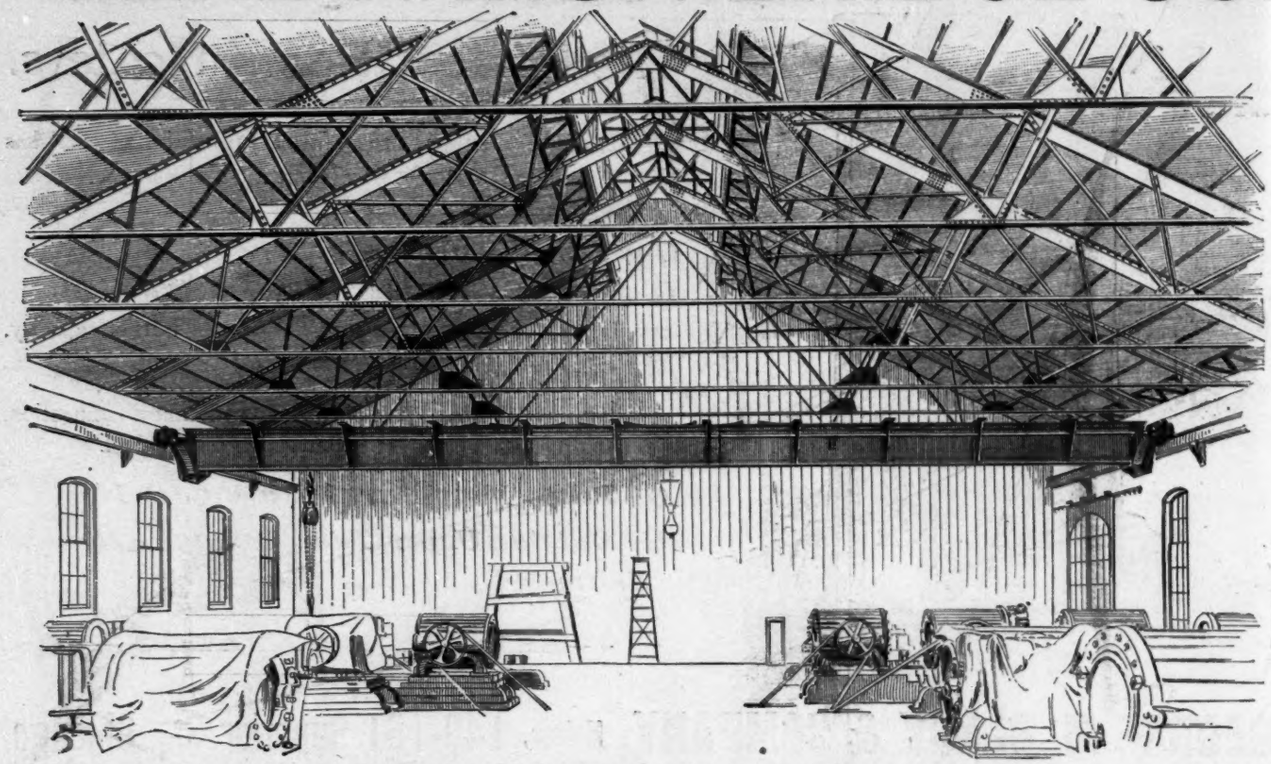

The above illustration, taken direct from a photograph, shows the construction of an Iron Truss Roof, with a Traveling Crane, both of which were designed and built by us for the Narragansett Electric Lighting Company, at Providence, R. I. The illustration is taken in the Dynamo Room, which is 60 feet in width by 200 feet in length. The side walls are of brick, with iron roof trusses covered with our Patent Anti-Condensation Corrugated Iron. This is the first roof ever built with this Patent Anti-Condensation Corrugated Iron, and after passing through three severe winters has shown no signs whatever of any dripping or sweating on the Corrugated Iron. We guarantee this Anti-Condensation Iron Roof Covering not to drip in the coldest weather.

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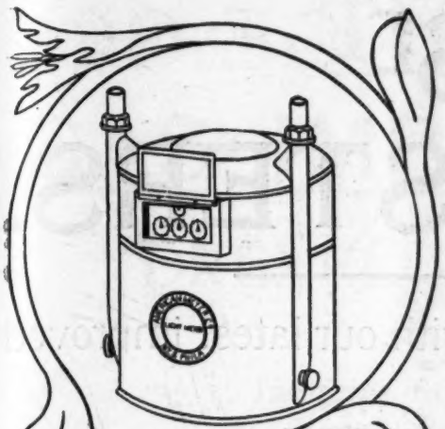

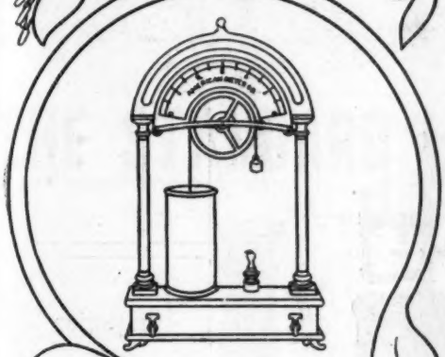

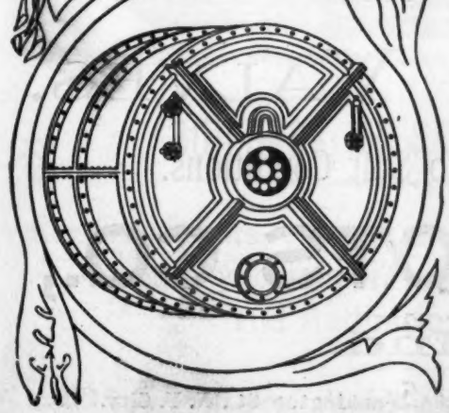

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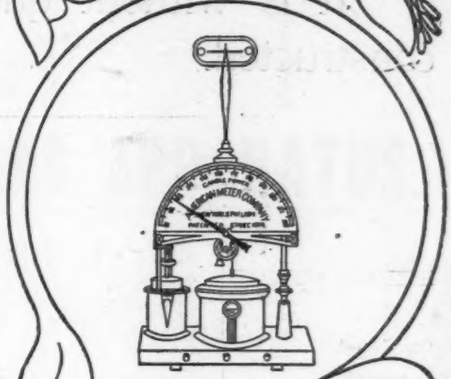
PUBLIC LIGHTING TABLE.

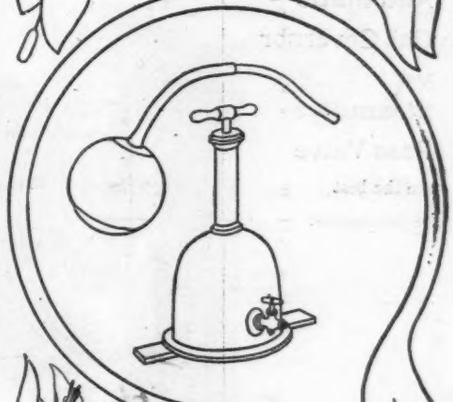
FEBRUARY, 1895.

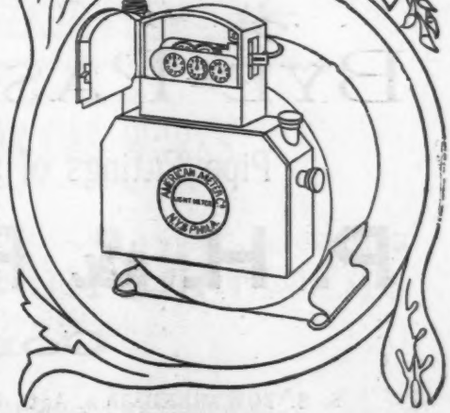
Day of Week.	Date.	Table No. 1. Following the Moon. Light.	Table No. 1. Following the Moon. Extinguish.	Table No. 2. New York City. All Night Lighting. Light.	Table No. 2. New York City. All Night Lighting. Extinguish.
				P.M.	A.M.
Fri.	1	11.10 PM	6.10 AM	5.05	6.15
Sat.	2	12.20 AM FQ	6.10	5.05	6.15
Sun.	3	1.30	6.00	5.05	6.15
Mon.	4	2.40	6.00	5.05	6.15
Tue.	5	3.50	6.00	5.10	6.10
Wed.	6	4.50	6.00	5.10	6.10
Thu.	7	5.30	6.00	5.10	6.10
Fri.	8	No L.	No L.	5.10	6.10
Sat.	9	No L. FM	No L.	5.10	6.10
Sun.	10	No L.	No L.	5.10	6.10
Mon.	11	6.00 PM	9.10 PM	5.10	6.10
Tue.	12	6.00	10.20	5.20	5.55
Wed.	13	6.00	11.40	5.20	5.55
Thu.	14	6.00	12.50 AM	5.20	5.55
Fri.	15	6.00	2.00	5.20	5.55
Sat.	16	6.00 LQ	3.10	5.20	5.55
Sun.	17	6.10	4.10	5.20	5.55
Mon.	18	6.10	5.00	5.20	5.55
Tue.	19	6.10	5.40	5.30	5.55
Wed	20	6.10	5.40	5.30	5.55
Thu.	21	6.10	5.40	5.30	5.55
Fri.	22	6.10	5.40	5.30	5.55
Sat.	23	6.10	5.40	5.30	5.55
Sun.	24	6.20 NM	5.40	5.30	5.55
Mon.	25	6.20	5.40	5.30	5.55
Tue.	26	6.20	5.40	5.30	5.45
Wed.	27	6.20	5.40	5.30	5.45
Thu.	28	6.20	5.40	5.30	5.45

TOTAL HOURS LIGHTING DURING 1895.

By Table No. 1.	Hrs. Min.	By Table No. 2.	Hrs. Min.
January	237.00	January	423.20
February	196.40	February	355.25
March	195.50	March	355.35
April	165.30	April	298.50
May	153.40	May	264.50
June	138.20	June	234.25
July	146.30	July	243.45
August	152.50	August	280.25
September	165.10	September	321.15
October	186.10	October	374.30
November	204.10	November	401.40
December	219.30	December	433.45
Total, yr.	2161.20	Total, yr.	3987.45







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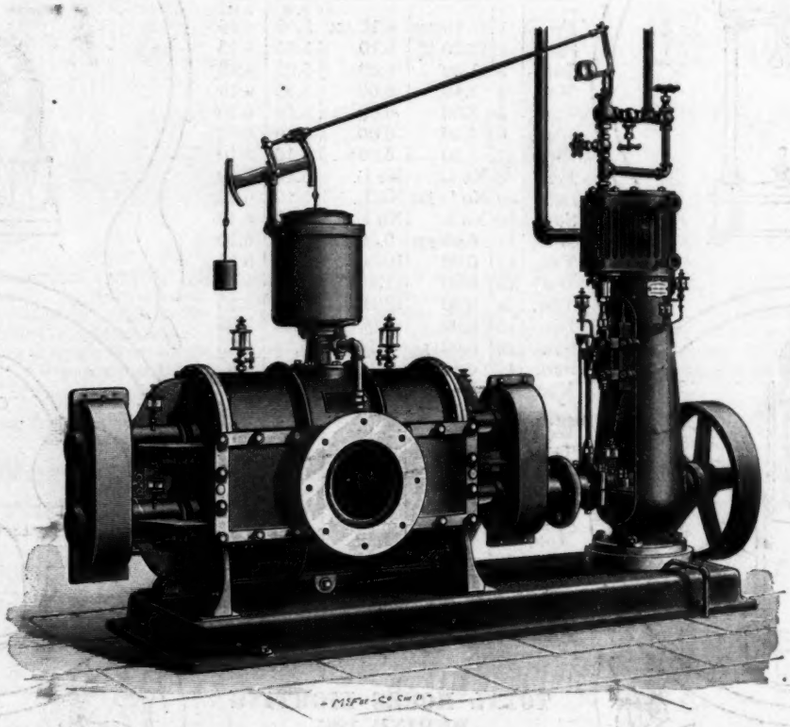

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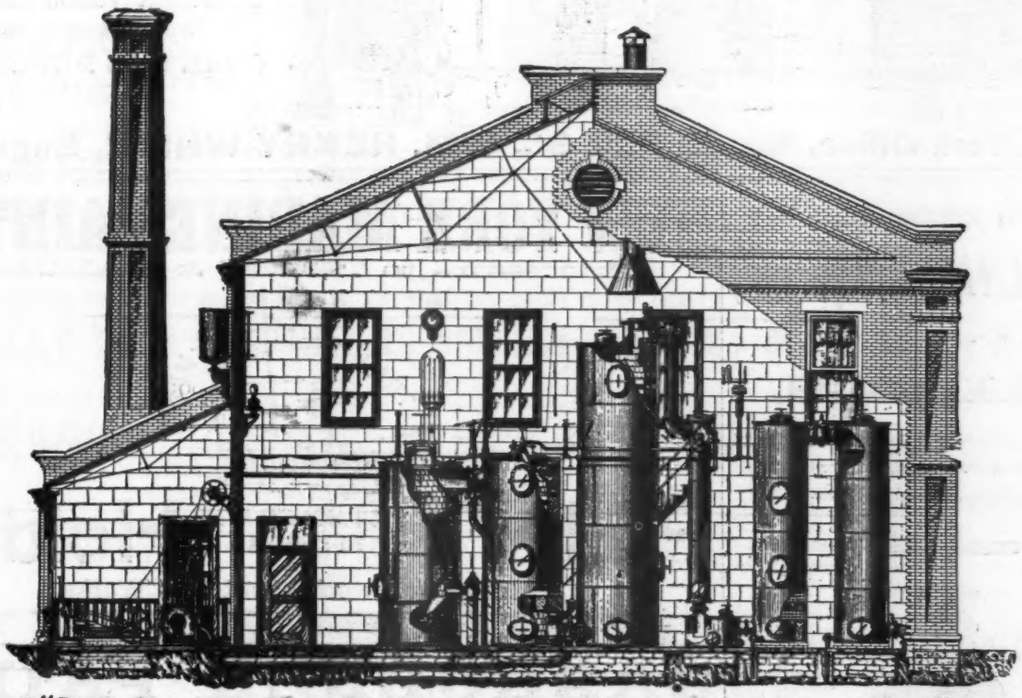

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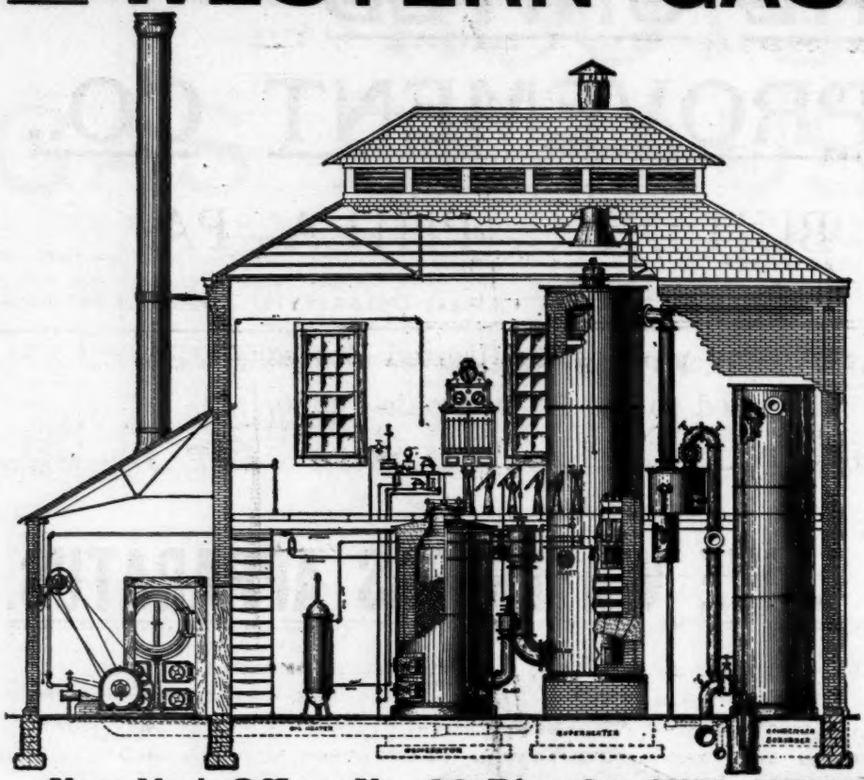

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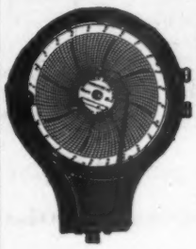

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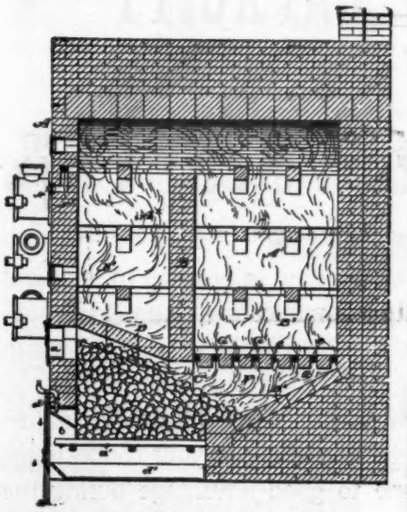

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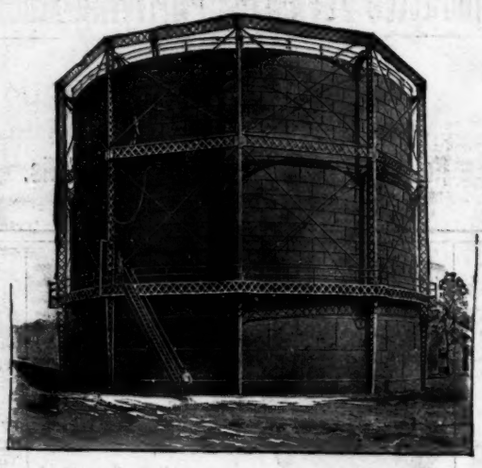

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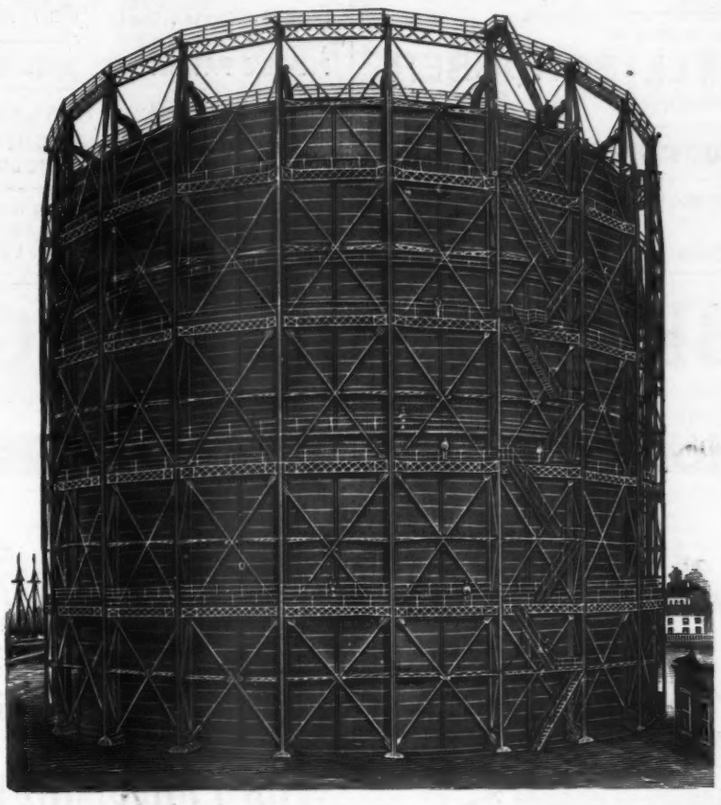

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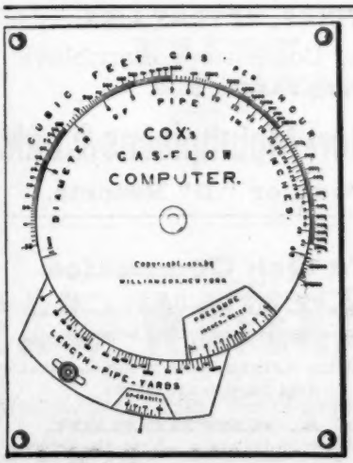

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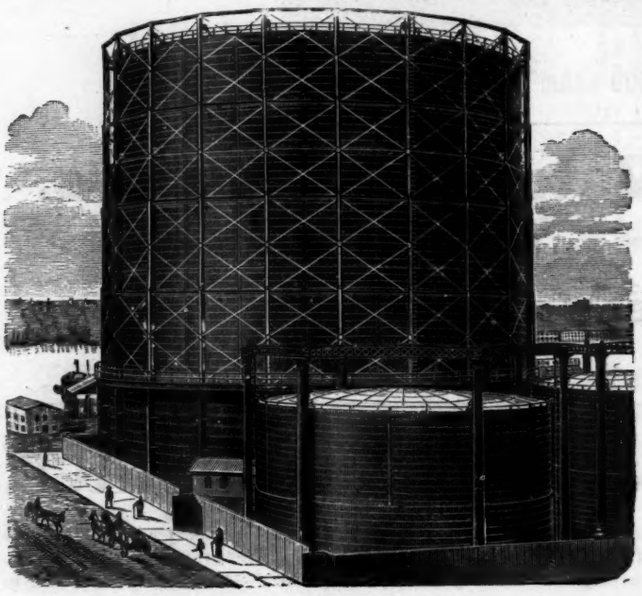

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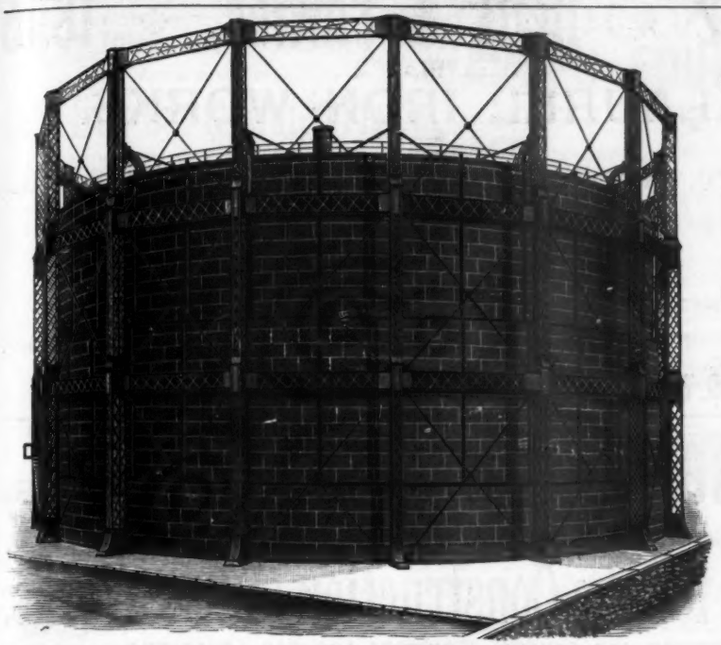

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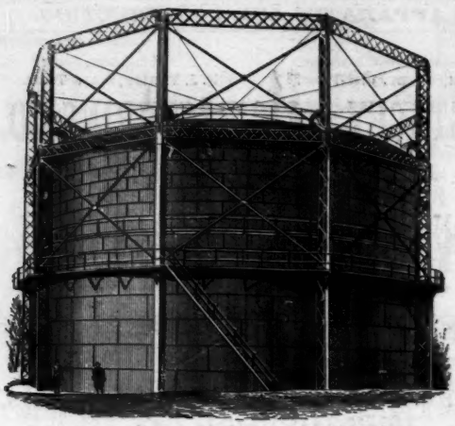

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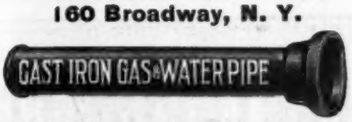

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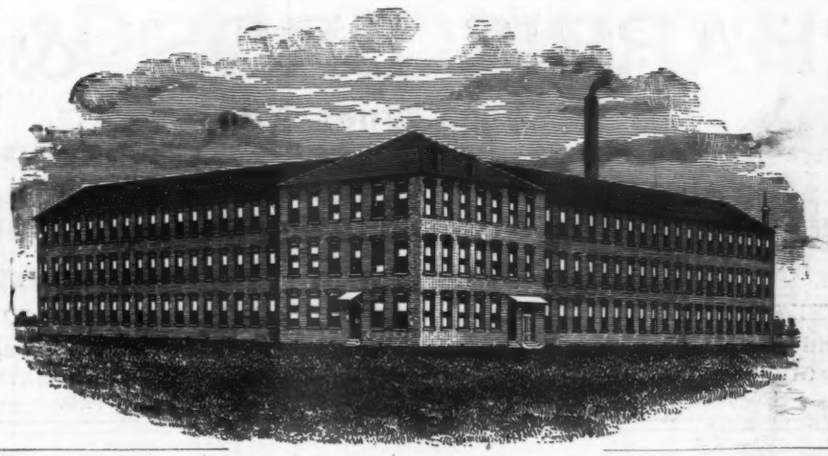

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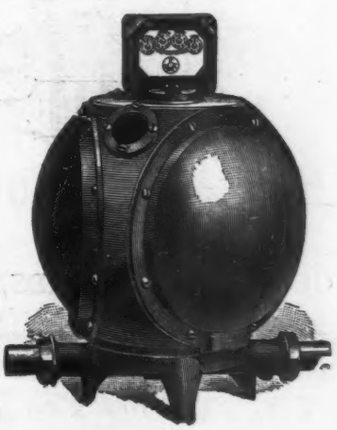

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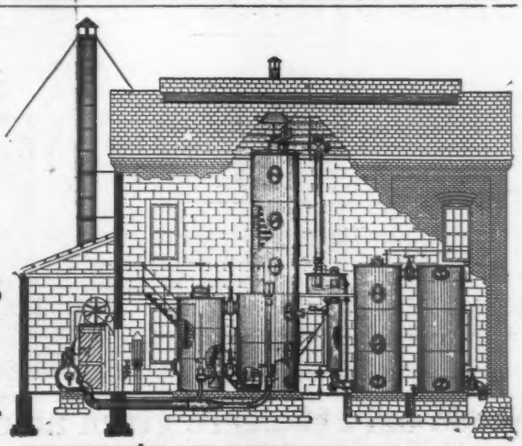

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